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THE PROGRESS OF ZOOLOGY.

BY SHIRLEY HIBBERD.

Zoology may be considered one of the most fortunate of sciences. Like a well-spread table, it has something to tempt every taste, milk for babes, and strong meat for men. Its subjects are so varied, many of them so familiar, and all of them have so direct a reference to life, that its very theories are romantic, and its facts oftentimes rise to the level of poetry. The affection of a dove for her nestlings, or the persistent faithfulness of a dog following the corpse of his master to the grave, that he also may die there, are matters that scarcely come within the domain of the science to which the modern term "Biology" has been applied, but they represent the sentiment which has been, and still is, the corner-stone of zoological science. The animals that are more immediately associated with man in his enterprises are those in which the most notable variations of form and colour occur; and the economy of civilization has required a more than casual investigation of the circumstances which influence their welfare, as well as of their relations to each other. The two most natural of all sciences—if such a term may be allowed—are zoology and botany: they deal with the material necessities of human life, with the best adornments of the world, and, above all, with organization. It is the possession of Life that renders a waving blade of grass or a chirping sparrow more attractive than an impassive stone. If there were no stone there would, perhaps, be no sparrow, they are both essential to the oneness of the world; but the sparrow has consciousness; it exhibits the working of mysterious instincts; it moves by volition *per se*, and it utters in its chirpings somewhat of an idea. It may be that we are searching after the Principle of Life as if it were a material substance or mathematical entity, forgetful of Stahl's definition, *putredini contrarium;* but any way we do search, and not in vain, for at every step some discovery is made which affords encouragement for perseverance. But we may adopt the term "natural," as applicable to

zoology and botany, in an especial sense, not because they treat of natural objects, for all sciences do that, but because their subjects are almost wholly contemporaneous, and those that are not so may be made so by the aid of analogy; so that even palæontology may be studied at the Zoological Gardens, and recent species among the models of extinct forms in the Crystal Palace. What Margaret Fuller expected of the sculptor may be as well expected also of the zoologist:—

> "If he already sees what he must do,
> Well may he shade his eyes from the far-seeing view."

Student and professor are alike concerned in one effort, and that is the separation of the natural from the artificial, and the proven from the conjectural, in all inquiries and all accumulations of facts. At the very threshold of zoology we perceive that there are many stumbling-blocks, and if we escape those without damage, we next perceive that there is a sort of antagonism between man and nature, the one insisting on creating, if he cannot find, a system, the other insisting that every fact shall stand for itself, and every creature enjoy an independent sovereignty. No doubt the plants and animals that redeem the world from stony deadness are so many members of a system as truly mathematical as the law which governs the relations of the planets; but man has not yet discovered what that system is, and until he has mastered the last little item of organography, he must perforce rely upon invention, and classify his knowledge by artificial rules. It is a wonderful testimony to man's power of perception and analysis that since the second edition of Cuvier's *Règne Animal* there have been scarcely any contributions to the classification of animated nature of a character to influence deeply the aspects of the science. Even those of Professor Owen, who, pursuing the indications of analogy with the instinct of a poet, has only been able to rectify in some few particulars the deficiencies of Cuvier's magnificent scheme. In fact, it is no easier for Owen than it was for Cuvier or Linnæus to define on what grounds a class, order, or genus shall be formed. Nature has no classes, no orders, no genera; she fashions creatures to lead a certain life, and places them in the conditions requisite to their well-being, and with a defiant nonchalance says, "Group them as you please;" and all that we can do is to define apparent relationships, and make a sort of artificial memory out of the signs presented to us. The acquisitions of anatomy and physiology have favoured the study of zoology in connection with the homologies of internal structure, and rendered zoology more recondite in the exact proportion in which its tests and comparisons have been removed from

popular eyesight; but it has yet to be proved that structure and function are alone sufficient to afford satisfactory evidence of relationship for the purpose of grouping the subjects of the science into families and classes. There is a tendency in the modern school of zoologists to consider form as an accident of life, and as very remotely connected with organization, whereas, though it be very objective, it is certainly the true key to structure and function. The botanists have the best of it in a choice between two systems; they are neither tied to Linnæus nor Jussieu: and while the system of the first is a mere aid to memory, and as such invaluable, the other is self-expounding, and conveys information in its very terms, yet becomes entirely artificial under false pretences, when its assumed "natural" principle fails in the application.

It has never been attempted yet to establish a parallel between Bacon and Linnæus, and show how the inductive method so differently dealt with by each became the substantial basis on which their successors in the several departments of physics and natural history have built up the edifice of modern science. The *Novum Organon* and the *Systema Naturæ* are the two great pillars which sustain the portico of the temple for the completion and embellishment of which so many energies have been evoked, and so many splendid abilities combined. When we compare the classification now generally adopted with the scheme of the mammalia which Linnæus so patiently elaborated, we are astonished at the few departures from it which have been found necessary in modern times. Cuvier found ready to his hand a magnificent framework, and he did well in boldly clothing it, to hold in reverence the genius of his Swedish predecessor, who had determined the true elements of zoology so accurately, and had invented a language so well adapted to a comprehensive natural system, that the supply of deficiencies were almost all that remained to be done. But the deficiencies were many, and in none of the groups has rectification been more necessary than in the section to which Linnæus assigned the opossums, in the order *Ferœ*, placing them between the bears, badgers, and racoons. Cuvier had the advantage of knowing most of the marsupials of Australia, and he arranged them in an order between the Carnassiers and Rodents, making the one great peculiarity in their mode of reproduction the basis of the order *Marsupiata*. This, as regards the mammalia, was the distinguishing feature of Cuvier's scheme, and it is the one most likely soon to undergo a complete revolution. It is in the classification of the tribes below the Mammalia, and especially the invertebrates, that Cuvier shines; as, on the other hand, it was amongst those that Linnæus lost himself, as witness his class "Vermes," into which he flung all the animals that

refused to take positions among vertebrates, or insects. To form a fair estimate of the progress of zoology in the classification of the orders in the vast stretch between Batrachians and Zoophytes, the *Systema Naturæ* must be explored, and its method of dealing with these compared with the labours of Cuvier and his successors. Still the principles of classification have remained nearly the same, at least since Cuvier, proving how truly he seized upon the characteristics really indicative of structural and physiological relationships. The most important proposal for a redistribution is that of Professor Owen for the division of the Mammalia into two great groups, the designations of which are self-explanatory. Under *Placentalia* he ranges all the higher mammalian forms in the same order as in Cuvier's scheme, but the marsupiates and monotremes are separated to form another grand division, called *A-placentalia*, in which the monotremes are ranged to correspond to the edentates in the first division, and as their counterparts with a less perfect mode of reproduction. But this, though based on obvious and important distinctions, appears to have found little favour with zoologists, and, like the labours of Grant and Blainville on the nervous system, is valued more for the prominence it gives to certain physiological facts, than for its adaptability to the purposes of classification in the present transition state of zoological science. These things are, however, the proper fruit of the labours in philosophical zoology which have been conducted with such ardour in Europe during the past half century, and we seem now to be waiting for a second Cuvier who shall boldly grasp the distinctive features of the animal kingdom, and arrest for a time the growing tendency to trifle with zoological landmarks by a revision of all boundary lines, and fitting into their proper places all that is true and durable in the various systems that have been of late propounded.

The frequent varying of the basis of classification, though inevitable, is not the less destructive to harmony, and that correspondence of mutual relationships which a system professes to unfold. That homologies of structure are to be regarded as of the first importance in the determination of the place an animal is to occupy in a natural system is self-evident; but it is worth asking, whether a purely artificial system would not serve as useful a purpose in zoology as it has done in botany, because it could be framed once for all, and serve for comparison at any future time with a progressive natural system, which of necessity can never be perfect. Pliny excites the laughter of the young naturalist when he describes the cat as the *only bird* that suckles its young; but a strictly homomorphic system would have its value, and the wonder is that no one has ventured hitherto to propose a scheme of the kind. Bats,

squirrels, and marsupiates claim relationship with birds in their faculty of flight; the quadrumanes might as well contribute the marmosets to the family of squirrels, and the Douroucouli to the cats, as retain them for the doubtful character of their hands. The armadillo, *Dasypus apar*, is more like a turtle than a mammal; the Aard-wolf, *Proteles Lalandii*, is a hyena in its external aspects; the Cetacea are fishes, to all intents and purposes, in their habits of life, as well as in general form. Perhaps the difficulty of classing the marsupiates might be got over at once by homomorphism, for as at present regarded they threaten the boundaries of Rodentia, Carnivora, Cheiroptera, and Testudinata, and a classification resting on external configuration would serve all the purposes of an index to species without impeding inquiry into physiological and anatomical details. As it is, the natural system affords only a few faint indications of character, and the fault of all natural systems is that as soon as they cease to indicate correctly they lead the student astray, for after a few of the most characteristic groups have been defined—as in botany the Coniferæ, the Cupuliferæ, and the Ranunculaceæ, and in zoology the Quadrumana, the Carnivora, and the Rodentia—there are innumerable other subjects that refuse to conform to distinct positions by reason of their combining the characteristics of many. No system can suffice to indicate the place, for instance, of that curious vertebrate, *Amphioxus lanceolatus*, which, emulating the chameleon, has a life on one side, which has no necessary conformity on the other. The chameleon may sleep on the left side, while the right side is awake, and in the *Amphioxus* the bronchial aperture, the olfactory organ, and the eye, are all situated on the left side. The *Chamælonidæ* are, however, a well-defined group of saurians, but the *Branchiostoma* is as indefinable for scientific purposes as any of the cattle of fairyland. There is certainly room for an artificial system of zoology of a comprehensive kind for the tabulation of the entire animal kingdom.

Looking at the several departments of zoology in their present aspects, it is evident that the most satisfactory progress has of late years been in the study and classification of the lower forms of life. The aquarium and the microscope have given an impetus to the study of the Invertebrata, and such immense additions have been made to the knowledge of this great section, that the mere weight of facts threatens to separate it from the hitherto recognized connection with the vertebrates, and so to constitute in zoology two distinct sciences, the future paths of which will be separate though parallel. It is in this section that we have most striking evidence of the abundance of life in every region of the globe. Dr. Wallich and Mr. Gwyn Jeffreys have, by their researches on the subject of deep sea

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life, enlarged immensely the geographical limits and the physical conditions known to be favourable to the production of animal life. In that still lower department of the Infusoria, the magnificent work of Pritchard offers another example of the splitting up of old divisional arrangements through the accumulation of facts indicative of distinctive characteristics. The publication of a fourth edition of this work, combining the labours of Arlidge, Archer, Ralfs, Williamson, and Pritchard, with the magical delineations by Mr. Tuffen West,* is a sufficient proof that natural history flourishes in Britain, and that the objects least attractive to the popular eye are acquiring a popularity, such as to assure us that the cultivation of science is almost universally shared in by the intelligent classes of this country. But when we get among desmids and diatoms we have almost done with zoology, and we may take advantage of this extremity to offer a few remarks on the higher forms of the vertebrata.

If we are astonished at the abundance of life on the globe, and can sympathize with Dr. Livingstone's remark, that it "seems like a mantle of happy existence encircling the world," it is also pretty certain that some of its forms are fast passing away from us, and that not very far in the future the zoologist will pay as much attention to mammals recently extinct, as we do to certain fossil forms, because they fill up gaps in our classified system of transitions. That the dodo is utterly extinct there can be no reasonable doubt, for the region it inhabited has not only been thoroughly explored, but is now densely populated. The kiwi or apteryx is fast going in the same direction, and as the interior of New Zealand becomes a home for the white man, that and other feræ must of necessity disappear. The last dinornis has probably long since perished; yet it could not be long since there were at least eight species of dinornis, varying in size from that of the bustard upwards, *D. giganteus* being vastly superior to the ostrich in magnitude. The great quadrumana will probably be the next to disappear, for civilization will not tolerate the existence of anthropoid apes, and the mere savagery of what is called "sport" will extinguish them. The gorilla evidently occupies but a limited range of country, and that near the coast, and the tendency of civilization is to people the coast everywhere with colonies of Anglo-Saxons, French, and Portuguese, respecting whom it is not easy to say which are the most active in the destruction of indigenous fauna. The beaver still holds a few secluded weirs in the North of Europe, but no one can say when it became extinct in Britain. The otter is so scarce in this country that the sport

* *A History of Infusoria, including the Desmidiaceæ and Diatomaceæ.* By Andrew Pritchard. London: Whittaker and Co.

of hunting it is almost obsolete, yet it is only thirty years since the finest otter ever seen in Britain was shot at Walthamstow, on the borders of Epping Forest, where it may still be seen in a very fair state of preservation. Of the *Falconidæ* there are few living examples left in these islands, and the eyrie of an eagle is as rare in England as the nest of a thrush in France, where the most melodious of songsters is valued only for its flavour in a pasty by a people who make great pretensions to the culture of the sentimental. The noble blackcock and the ignoble black rat appear to have vanished almost simultaneously from the British fauna, and the fox is probably following the wolf in full conviction that its mission is accomplished. Indeed the fiercest war maintained by man against animal races, is waged against the carnivora and the raptorial birds. In the Biblical narrative there are numerous evidences of the abundance of beasts of prey in Palestine and Phœnicia, where there is now scarce anything more rapacious than a fox to be found. David's adventure with the lion and bear could not now be repeated by any brave shepherd within a hundred miles of Jerusalem, and the traveller on the Euphrates and Tigris need entertain but little fear of those hungry lions which figure so conspicuously on the hunting freizes of Nineveh. Man not only lays the whole animal kingdom under tribute to furnish him with meat and labour, and entertainment and knowledge, but he busies himcelf to disturb the balances, and the gamekeepers of this country might be collectively described as destroyers of the British fauna. The relations of Sir Emerson Tennent and Dr. Livingstone made it pretty evident that the "half-reasoning elephant" is fast passing from the face of the earth to be numbered among the extinct animals by the naturalists of a century hence. When we read of the wanton slaughter of thousands of elephants with no object but the gratification of the passion for destruction, we are tempted to lament that man possesses such complete dominion to subjugate, and such unlimited power to destroy. "Had the motive," says Sir Emerson Tennent, "that invites to the destruction of the elephant in Africa and India prevailed in Ceylon, that is, had the elephants there been provided with tusks, they would long since have been annihilated for the sake of their ivory. But it is a curious fact that, whilst in Africa and India both sexes have tusks, with some slight disproportion in the size of those of the females, not one elephant in a hundred is found with tusks in Ceylon, and the few that possess them are exclusively males."* In Africa the hunger for meat and ivory causes the destruction of the elephant to an extent which threatens soon to extinguish the large-eared

* *Sketches of the Natural History of Ceylon, with Narratives and Anecdotes, &c. &c.* By Sir J. Emerson Tennent, K.C.B., LL.D., &c. Longmans and Co.

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species altogether, but with neither of these incitements, it is perhaps being extinguished with still greater speed in Ceylon and India. There is a saving clause in the fact now established, that elephants will breed in captivity, but against it must be set the fact that in captivity it does not pay for its keep, and is scarcely worth the attention of those who employ it either for burden or draught. The elephant has too much character, too high a reasoning faculty, to be perfect as a servant; it has too many whims, too many eccentricities of temper, and consumes far more food than it earns in harness. Thus economically regarded, everything is against its preservation, and when the wild herds disappear, there will probably remain but few in a domesticated state, for unlike the horse, ox, ass, and sheep, it is both unprofitable and unmanageable.

Zoology has been somewhat restricted in aim, spite of its own breadth as a science and the liberality of its leading cultivators. It owes most of its advance in recent times in the absorption into its circle of the facts of past biological history to Professor Owen, whose "Palæontology" is a sort of panorama of extinct forms, placed side by side with their existing congeners and representatives. Australia and New Zealand have not only furnished innumerable subjects of anomalous kinds for the consideration of system makers, but they have opened the way for rays of light to fall on the present direct from the past, by their illustrations of geological eras. Nothing more strikingly exemplifies the relationship that subsists between all departments of knowledge, than the aid which zoology and geology respectively offer to each other. The existing fauna of Ceylon, as analyzed by Sir Emerson Tennent, affords very satisfactory indications that the island is, in no geological or zoological sense, an outlier of the vast Indian continent, but a site *sui generis* like Australia, detached not only in its geography from the neighbouring continent, but in its chronology also, and in all its organic productions. On the other hand, geology does more than whisper of the connection that once subsisted between England and the Continent of Europe by way of the straits of Dover, for it furnishes all the evidence requisite to establish the conclusion that the separation was effected not very long antecedent to the commencement of the historic era. Zoology does not touch the chronology of the question, but it affixes the general conclusion; and we begin to discover that, however valuable are the floras and faunas of Britain, they tell but half their proper story unless considered in connection with the floras and faunas of the Continent.

Two admirable works have recently been published, with the object of indicating the relations of British and Continental zoology. That by Lord Clermont is a compilation, but it is

accomplished with so much skill and good taste, that it acquires a character of originality both by its purpose and its merits.* The British fauna is a part of the fauna of Europe, just as the fauna of a county is a part of the fauna of the country at large: and Lord Clermont's work will tend to widen the range of the British naturalist, by showing that many of his subjects have an extensive area, and must be studied under all their several geographical conditions for a full knowledge of their habits and physiology. Dr. Bree,† though working in another direction, points to the same lesson. By registering the birds of Europe *not* found in Britain, he enables us to estimate the close connection by reason of community of species which exists between the aves of Britain and the Continent, so that we can lay claim to but very few as exclusively British.

The great scientific question of the day is, What is a species? We shall not attempt to offer a reply. Mr. Darwin has made as great an agitation in the world of science as the *Essays and Reviews* have in theology, but there is no process of excommunication known in the zoological establishment; and those who differ from Mr. Darwin can heartily thank him for having put their accepted formulæ to a severe test, and opened an almost new channel of inquiry. If there is a vagueness about the characters of species, there is still more about the meaning of varieties. Has it never occurred to the reader that every animal is, in a certain sense, a variety; that every individual creature has a distinctive character of its own; so that our so-called varieties are such only by reason of a greater departure from type than usual, the fact of departure being itself so universal that type is almost undiscoverable. Sir Emerson Tennent says every herd of elephants in Ceylon has some distinctive features; in one herd the individuals are affected with red spots on the skin, in another the tushes are more fully developed; and what is more remarkable, as bearing on this question of species, it appears that every separate herd is a separate family, bound by ties of consanguinity, so that we may suspect—the case not being proved—that the distinctive family characters, which give every herd some peculiarity of form or colour, is the result of breeding in and in, which every flockmaster and poultry-keeper knows to be remarkably productive of what are called permanent varieties. The African elephant appears to be equally subject to variety as those of India and Ceylon. In his twenty-seventh chapter

* *A Guide to the Quadrupeds and Reptiles of Europe.* By Lord Clermont. London: John Van Voorst.

† *Birds of Europe not observed in the British Isles.* By Dr. C. R. Bree. London: Groombridge.

Livingstone says, "On the Kalomo we met an elephant which had no tusks—as rare a sight in Africa as one with tusks is in Ceylon." So in the proportions of the beast it varies so much that the rule that twice the circumference of the fore-foot equals the height of the animal has many exceptions, and one measurement is by no means a certain indication of the other.

The facts accumulated by Darwin and his coadjutors in this inquiry place the question of species in a very different light to that in which it was regarded by Lamarck. External influences and a power of adaptation to circumstances are terms that sound well and promise much, but they come to little when severely tested. *Felix qui potuit rerum cognoscere causas.* If the wading birds have acquired long legs by treading tip-toe on the muddy flats where they seek their food, how is it the ostrich has not, during more than 3000 years, accomplished a stretch of its wings? for it flaps them fiercely enough during its perambulations to cause growth if they were conformable to the alleged law of modification by circumstances. The fancy pigeons, which assume so many forms that we almost doubt at last if they are pigeons, maintain the specific characters of the wing almost unaltered. The ibis of to-day is the same in all its characters as the ibis on the oldest Egyptian monuments; the same is the case with the African elephant as figured on ancient coins, and it becomes now a question whether any departure from type can long maintain its ground—whether, in fact, variation in a marked degree is not the first step in the process of the extinction of the race in which the variation has occurred. The turnip and the potato as now cultivated in our fields are varieties secured by *artificial* selection, and they appear to be fast declining in vigour, so much so that farmers are seeking substitutes for both, to fill the places in the routine of tillage, which they threaten soon to leave vacant. In these cases the process of Nature seems to be only permissive as regards varieties, and that but for a season; they must revert to type or disappear.

In the applications of zoology, especially in connection with physiology, which is the key to zoological secrets, this question of species has more than a technical value. The whole interests of civilization are bound up with it. The patriarch Jacob was evidently an adept in cross breeding and the selection of races, and observed the law that "like produces like" with as much discretion as Mr. Jonathan Webb, the modern master of the art of sheep breeding. Dr. Beke, who has just traversed the country where Jacob grew rich in tending Laban's flocks, reports that "ring-straked, speckled, and grisled cattle" abound there, and apparently within such a circumscribed range as to render it probable that the race has maintained its integrity

since the day of the patriarch's servitude, which our marginal Bibles place at a date 3600 years antecedent to the present time. The tailless cats of the Isle of Man and the tailless poultry of Burmah are scarcely to be traced back to their parentage, and have all the characteristics of true species as far as their constancy of reproduction is concerned. In his twentieth chapter Livingstone says, "Near Massangano I observed what seemed to be an effort of Nature to furnish a variety of domestic fowls capable of bearing with comfort the intense heat of the sun. Their feathers were curled upwards; thus giving shade to the body without increasing the heat. They are here named 'kisafu' by the natives, and 'arripiada,' or shivering, by the Portuguese. There seems to be a tendency in Nature to afford varieties adapted to the convenience of man. For instance, a very short-legged species of fowl was obtained by the Boers, who required one that could be easily caught in their frequent removals. A similar instance of securing a variety occurred in the short-limbed sheep of America." Such things as these are matters of daily observation; the question is, to what law are they subject, or, in other words, what is the philosophy of their occurrence? If Mr. Darwin had sent forth his book as a collection of data, instead of as the statement of an hypothesis, there would have been the same broad field for discussion, but with the advantage of greater freedom; for it is in vain to seek for the philosophy of varieties until we have arrived at an unexceptional theory of species, which we certainly have not, unless it be the vague definition that a species is a congenital expression of all the forces concerned in its production. Our conclusions for the present are provisional, and each new conclusion arrived at simply pushes the inquiry a stage farther back. The subject is as much one for experiment as for inquiry into the accidents of nature. The intermediate form between the horse and the ass is a mule, which is infertile with another mule of the opposite sex, and it is thenceforth concluded that all hybrids of a given class are incapable of procreation among themselves. But M. Rouy, of Angoulême, is reported to breed hybrids between the hare and the rabbit by thousands for the market, and these leporines are further stated to be fertile both with the hare and the rabbit, and with each other. Some of these leporines have borne young in the Gardens of the Zoological Society, but whether they are of the first cross is at present unknown. The differences between the two types are many, yet they are rather in degree than kind. The heart of the hare is nearly five times the weight of that of the rabbit, the lungs are nearly four times as heavy, the calibre of the trachea three or four times as great. Furthermore, the period of gestation in the hare is

understood to be a month, that of the *wild* rabbit three weeks; the young of the rabbit are born blind, those of the hare see; the rabbit burrows, the hare seldom goes to earth. There is one great peculiarity of these hybrids of very great importance as to the question at issue—the males show a great disinclination to copulation, which is very different to the males of the (so-called) species, and if we were to suppose such a cross to arise in nature, we must almost suppose it would soon be lost through this very peculiarity. But much more interesting cases bearing on the same question were communicated by Dr. Crisp, in the paper from which we have gathered the above particulars.* Four hybrid ducks were bred at the Zoological Gardens between the summer duck (*Anas sponsa*), the pochard (*Fuligula ferino*), and the ferruginous duck (*Fuligulo nyroca*). It is true that in these instances the parent species are in structure and habits very nearly allied, and the only difference of importance is, that the summer duck has eight pairs of ribs, the others have nine; but an extra pair of ribs is no proof of specific distinctness, for in man an extra pair occurs occasionally, and in the anthropoid apes there is sometimes a pair of ribs and one or two vertebræ above the typical number, and the ribs themselves are but elongations of processes with which every segment of the vertebral column is furnished. But these facts compel us to ask still more eagerly, what is a species? Are the three species of duck just named specifically identical, and did the hare and the rabbit originally proceed from the same stock?

It will be observed that the most notorious cases of hybridization and variation occur in connection with the interference of man with the proceedings of Nature. Wild varieties are plentiful, but the range of variation is more limited. The first object of man, whether he subjects animals to an artificial mode of life for profit or amusement, is to cause them to produce varieties. One way or another he invariably makes attack on the organs of reproduction, or attempts a diversion of their functions from its normal course; and it is worth considering whether he does not unintentionally bring into action circumstances that will some day bring about an extinction of his varieties, unless their vigour is occasionally replenished by the infusion into it of wild blood. The frequent crossing of the most valued varieties of domestic animals indicates somewhat of a recognition of this fact, that varieties tend to die out. In the case of the animals used in agriculture, the practice of castration must have some effect in diminishing the vigour of races. The males castrated are at once removed for ever from

* *Proceedings of Zoological Society*, Feb. 12, 1861, paper by Edward Crisp, M.D., F.L.S.

the domestic circle, and no variation or deterioration of the race can possibly arise through their communication of a diminished vital force. But their removal throws the task of procreation on a fewer number of males, and a given amount of procreative force is of necessity spread over a larger surface; in other words, every ram, bull, and stallion has to beget a larger number of progeny than it would do in a state of Nature, and that progeny, it seems fair to assume, must inherit less of the initial vigour which is the foundation of the physical constitution of the individual. Variation itself, apart from this consideration, appears to be in the majority of cases congenital, and so representative of the circumstances attending the physical origin of the individual life. The story in the *Cloud of Witnesses* of a man yielding milk when a child was put to his breast during the persecution in Scotland, receives some confirmation from the account given by Humboldt of a human male that gave forth milk. Livingstone tells of grandmothers suckling grandchildren, which are cases quite to the point, and evidently of the class of congenital variation. In the individual, castration has an immense influence in modifying all the characteristics peculiar to the male sex; and barren females and impotent males, whether of the genus *Homo* or any other genus, are influenced in their whole physical character in a manner consistent with their exceptional sexual condition. Among our domestic horned animals, the size and configuration of the horns vary so much from the normal type, that we have a tolerably safe index thereby to the whole pedigree of the races, and congenital peculiarities are most strikingly exhibited in the variations which the horns exhibit. It is said that if a stag is castrated when his horns are in a state of perfection they will never be shed; that if the operation is performed when the head is bare they will never be regenerated; and if it is done when secretion is actually going on, a stunted, ill-formed, permanent horn is the result, more or less developed, according to the period at which the animal is emasculated.* In the museum of the College of Surgeons is the head of a fallow-deer, bearing a pair of half-developed horns unequal in size, and wholly without palmations, but of unusual thickness, and covered with wart-like protuberances resembling incrustrations. This animal was castrated; the horns were not shed at the usual time, and they shortly afterwards acquired the peculiar character which renders them so unique as specimens.

In horned animals that have never been subjected to domestication, there is a remarkable constancy of character in the development of the horns and their symmetry. The beau-

* *English Cyclopædia*, Nat. Hist. Cervidæ, c. 843.

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tiful lyrate horns of the *Kobus maria* (Gray), a new antelope from Central Africa, afford a fair sample of the beautiful proportions and graceful outlines common to all horned animals in a wild state; and though no antelope from Central Africa could be expected to prosper in our climate, so as to form an addition to the embellishments of an English park, the southern regions of the same continent offer numerous species equally beautiful for economic as well as decorative uses in this country. (Fig. 1.)

Another equally beautiful example is that of the Sable Antelope, *Aigocerus niger*, recently added to the collection of the Zoological Society from the mountainous region lying to the north and east of Southern Africa. The graceful crescent-like sweep of these horns, upwards of three feet in length, would, doubtless, soon undergo such modifications as would make an end of their beauty if the animals were reduced to domestication, and a breed secured for market purposes. (Fig. 2.)

That we are not giving undue importance to this subject may be determined any day in Smithfield market. The tendency of breeding is to destroy horns altogether. Our best breeds of sheep are now hornless. Many of the most esteemed breeds of cattle are also hornless, and of those that still possess those appendages, the *short horns* are the most prized. In the few forests that still shelter the deer in Britain, fine specimens of horns are rare, and the "muckle Hart of Benmore," stalked by the late Mr. Charles St. John, was probably the last of its race for magnitude of frame and antlers. So the goat having altered less than any of the animals of the homestead, because less cared for than all the rest, retains his "crescented cornua" in all the breeds except the Spanish, which is the most fertile, the most improved according to agricultural standard, and the most easily managed, because by loss of horns rendered harmless. Bucks of this breed do occasionally wear the proper sign of Capricornus, but they are becoming more rare every day. But Nature defends her types with some obstinacy, and rather than part with them when the current of her aims is turned aside by the inventions of man, she sometimes pursues an opposite course, and in the case of horns the development is then such as to indicate a stronger probability of extinction than when horns are obliterated altogether. A curious example of this is the Galla, or Sanga Ox of Abyssinia, of which Bruce gave the first account, alleging that "the extraordinary size of the horns proceeds from a disease that the cattle have in these countries, of which they die, and is probably derived from their pasture and climate. * * * * His value then lies in his horns, for his body becomes emaciated and lank in

Fig. 1.—Symmetrical Horns of Kobus maria (Gray).

Fig. 2.—Symmetrical Horns of Sable Antelope (*Aigocerus niger*).

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proportion as the horns grow large; at the last period of his life the weight of his head is so great that he is unable to lift it up, or at least for any space of time." Mr. Salt, who saw these oxen in Abyssinia, denied that the size of the horns was occasioned by disease; but Mr. Vasey, in his *Delineations of the Ox Tribe,* insists that Salt's own evidence is against him, and he reproduces a figure from Salt to substantiate Bruce's account of the animal being both "lank and emaciated." We have copied the head and horns from Vasey's plate (Fig. 3), which will give the reader an idea of the disproportion between the horns and the head that carries them. This is usually considered to be a variety of *Bos Taurus,* but there are some differences which Mr. Vasey considers sufficient to render the identity doubtful. In the specimen of the Sanga, in the museum of the College of Surgeons, which is not the largest that has been seen, the horns measure 3 feet $10\frac{1}{2}$ inches in length round the outer curve; the distance between the tips is 3 feet 4 inches, the circumference at the base 1 foot 3 inches; and the distance between the bases at the forehead, $3\frac{1}{2}$ inches. The last measurement is certainly favourable to Bruce's statement, for it implies a narrowness of the frontal plate quite out of proportion to the enormous magnitude of the horns. According to Livingstone, the Bakalahari, one of the oldest of the Bechuana tribes, possessed "enormous herds of the large-horned cattle mentioned by Bruce, until they were driven into the desert by a fresh migration of their own nation," and their loss of them may be attributed to their occupation of an almost rainless region unfitted for the support of herds of cattle, rather than to any inherent weakness in the large-horned race. The Hungarian ox, which has horns measuring 3 feet $4\frac{1}{2}$ inches, with a distance between the tips of 5 feet 1 inch, though known to be a variety of *Bos Taurus,* resembles the Sanga in the narrowness of the head, which is so neatly and delicately formed as to appear unfit to carry such enormous appendages. The Arnee, a native of the higher parts of Hindostan, has horns of still greater dimensions than either of the preceding examples of the genus *Bos.* A pair in the British Museum measure in length from tip to base 6 feet 6 inches and 6 feet 3 inches respectively, but the animal is reported to measure usually twelve, and sometimes fourteen feet from the ground to the highest part of the back. To quit this subject we subjoin a figure of the head of a four-horned sheep in the possession of the writer, in which the horns are remarkably unsymmetrical and largely developed, the result of imperfect castration. (Fig. 4.)

Whatever may be the ultimate effect of hybridizing and domestication, society looks to zoologists for assistance in

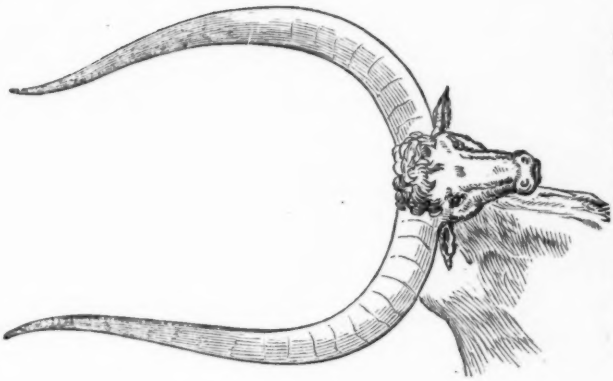

Fig. 3.—Horns of Sanga Ox of Abyssinia.

Fig. 4.—Four-horned Sheep (unsymmetrical).

increasing the necessities and comforts of life by an utilization of acquired knowledge. The Zoological Society has done so much in the way of acclimatizing animals suited to vary the supplies of our tables, that we look to it for something more: the contribution, for instance, of a few new dishes, for it begins to be a discredit to us that, having laid the world under tribute for its animal products, our staple animal foods should still comprise so small a round as beef, mutton, and pork, varied only by inversion to pork, and mutton, and beef. The kangaroo, which affords the choicest of all dishes to the Australian squatter, has been found to prosper in English parks, and is remarkably prolific and manageable. We may some day see herds of elands among the pasture stocks, for it is now thoroughly acclimatized at Hawkstone and Taymouth; but there are numerous antelopes, Himalayan partridges, and species of *Ovis* and *Caprea* that prosper in this climate, and might become permanent additions both to our fauna and our food resources. The nilgai, the largest of the Asiatic antelopes, breeds freely in the Society's garden, and produces two fawns at a litter. The Sambur deer (*Rusa aristotelis*) is proved to be as hardy in England as any of our domestic cattle. The Persian deer (*Cervus Wallichii*) promises to become permanently established. The Barbary deer (*C. barbarus*) is bred by Viscount Hill, at Hawkstone, and has been seen in England in the form of meat. The pretty Ceylonese deer (*Hyelaphus porcinus*) breeds readily in confinement, and might be distributed for fancy culture as a household pet, and to vary the round of comestibles on festive occasions; and the magnificent species of wild sheep from Northern India and Tartary thrive so well in this country, that breeders might take note of them as offering the materials for new crosses with our domestic breeds, to stimulate with fresh vigour the future races of British sheep. It is odd that among nearly ninety species of antelopes now known, there is not one available for the purposes of the butcher. The ravages of pleuropneumonia and rot among cattle and sheep in this country, entail losses which, if the average annual aggregate were stated, would appear fabulous, afford, at least, one good reason for a bolder policy in the applications of zoological science. It would be a good beginning in such a desirable undertaking if the Zoological Society were to follow the example of the Horticultural, and appoint committees to cook and eat a few selected specimens occasionally, and having reported thereon, to arrange for the distribution of animals in pairs for peopling the parks and meadows, and, if possible, the paddocks, and waysides, and commons of Britain.

We remarked above that the literature of science is of late years distinguished by the number and value of monographs. We

have already referred to some of these, and must now be brief. The best *resumé* of the rectifications now generally adopted in the classification of the animal kingdom, is unquestionably Mr. Rymer Jones' *General Outline*,* and in this will be found, carefully digested, the results of recent inquiries into the structure and physiology of the Quadrumana, the Marsupiata, and the Reptiles. A Dutch zoologist, Professor Van der Hoeven, of Leyden, has published a valuable systematic work, which has been carefully translated by Dr. Clark. This is the best summary we have of the present state of zoology, and, as soon as it becomes known, will be generally accepted as a safe guide to the results of scientific endeavour in the rectification of fundamental principles.† The *Essay on Classification*, by Louis Agassiz,‡ is a grand analysis of the distinguishing features of the several departments of the animal kingdom. Professor Bell's *History of British Quadrupeds*,§ is a worthy companion to the same author's admirable *History of British Reptiles*, and the beauty of the illustrations give it that peculiar value which most of Mr. Van Voorst's books have—that of rendering zoology popular and attractive without lowering the tone of scientific teaching, or coupling with it the sin of inaccuracy, which is so wofully committed by compilers of popular books. But the best monograph of modern times is Mr. Gosse's *Actinologia Britannica*,‖ because it compasses untrodden ground, rectifies the errors of Johnston, who stood for this class until Mr. Gosse took it in hand, and develops a system of classification founded on observation, dissection, and experiment; it is, in fact, as near an approach to the model of a natural system as can be imagined in the present state of zoological science. If envy were pardonable, we would envy Mr. Gosse the two-fold capability of wielding pen and pencil with equal effect, and by reproducing living forms of a somewhat untangible character, so that whether by description or representation, we can not only identify them as counterparts of realities, but penetrate the secrets of their structure, as he himself has done by unwearied toil and perseverance, with the aids of the aquarium and the microscope. Jonathan Couch's *British Fishes*,¶ will probably supersede the great and glorious

* *General Outline of the Organization of the Animal Kingdom.* By T. Rymer Jones, F.R.S. London: Van Voorst. Third edition.

† *Handbook of Zoology.* By T. Van der Hoeven, Professor of Zoology in the University of Leyden. Translated by the Rev. W. Clark, M.D., F.R.S., etc. 2 vols. Longman.

‡ Longman and Co., and Trübner and Co.

§ Van Voorst.

‖ *A History of British Sea Anemones and Corals.* By Philip Henry Gosse, F.R.S. Van Voorst.

¶ *A History of the Fishes of the British Islands.* By Jonathan Couch, F.L.S., with coloured illustrations of all the species. Groombridge and Sons.

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work of Yarrell. There is a magic in colour where birds and fishes are delineated, and identification can only be safely secured by the assistance of coloured prints accurately drawn from the life. Mr. Couch has done thus much for British fishes, and deserves the thanks of all naturalists for the production of a work that was much needed, and that will add considerably to his high reputation. Mr. Vasey's work on the *Genus Bos** has evidently been a labour of love. It embodies the results of painstaking research extending over several years, and the spirit of careful discrimination and severe accuracy in which it is written, merit the attention not only of readers of books on natural history, but also of the writers of them, for guess-work is largely indulged in, and anecdotes are too often made the means of covering positive deficiency of zoological knowledge. We need monographs of the Equidiæ, Cervidæ, and Antilopeæ, in a similar style, and a gathering of the facts in each towards the determination of the relations of varieties to types, and the economical value of the species which are adapted to the climate of Britain. Another desideratum of zoological literature, is a comprehensive treatise on the distribution of the British fauna, for which Dr. Forbes's *British Quadrupeds* already affords a basis. If such a work were undertaken in the spirit and worked out to the completeness of Watson's *Cybele Britannica*, it would be invaluable, not only as affording information of the geographical range of any British species, but also of assisting to the determination of the relations of British to European zoology. Other monographs, which we cannot stay to eulogize as they deserve, are Mr. Blackwall's on *Spiders*, published by the Ray Society; Dawson's *Geodephaga Britannica;* and the *Dodo and its Kindred*, by H. E. Strickland and Dr. Melville. But the strictly popular works of the present day are mostly built on substantial frameworks, and the fragmentary knowledge they communicate to the great class known as "general readers" is good of its kind, carefully arranged, and reliable as to detail. The Rev. J. G. Wood's *Natural History*† is the best sample we know of the popular method of treating a scientific subject, and it is due to its amiable and industrious author to say that he has gathered pearls from many seas, and strung them on thread that will bear some critical tension. It is the best and most beautiful popular work now before the public.

* *Delineations of the Ox Tribe, or the Natural History of Bulls, Bisons, and Buffaloes.* By George Vasey. Biggs, 421, Strand.

† Routledge, Warne, and Routledge.

WORK FOR THE TELESCOPE—PLANETS OF THE MONTH—DOUBLE STARS.

BY THE REV. T. W. WEBB, F.R.A.S.

PLANETS OF THE MONTH.

MERCURY will be favourably situated towards the end of the month, and may be looked for with the naked eye, between sunset and 10 p.m.

Venus continues very brilliant in the mornings.

The transits of Jupiter's satellites and their shadows will occur as follows:—

May 1st was included in our last number. 4th, III. emerges at 11h. 14m.: its shadow enters at 12h. 12m. 8th, I. enters at 11h. 36m.: its shadow at 12h. 42m. 10th, shadow of I. goes off, 9h. 27m. 11th, shadow of II. emerges at 10h. 49m. III. enters at 11h. 34m. 12th, IV. enters at 10h. 40m. 17th, shadow of I. comes on, 9h. 6m., the satellite itself leaves at 10h. 12m.: the shadow at 11h. 22m. 18th, shadow of II. enters at 10h. 37m. II. goes off, 11h. 24th, I. enters at 9h. 47m., and departs at 12h. 4m.: the shadow's ingress is at 11h. 1m. 25th, I. comes on, 10h. 40m. 31st, I. enters at 11h. 40m.

It will be observed how much the satellites and shadows have widened their distance in proportion to the increasing departure of the planet from opposition to the Sun. There may be some hope of dark transits on 4th, 11th, and 12th; but we must look out carefully, for the planet is getting further from the Earth, and by the end of the month his diameter will have diminished to 35″·4.

The most interesting phenomenon in the heavens at the present season is unquestionably the disappearance of the ring of Saturn, which will take place May 18, from which time, till August 12, the planet will appear destitute of this magnificent ornament, if ornament that may be called, which is no doubt so constructed by the All-wise Creator, as to subserve the most important and beneficial purposes. The cause of the phenomenon is pretty generally understood; but it may be well to refer to it in this place on account of some curious details connected with it. The position of this great plane (or rather assemblage of planes—*the only flat surface that we know of in the universe*) does not coincide with the plane of the orbit of Saturn: if it did, it would always present its edge to the sun, and neither of its sides would receive more than a horizontal illumination. Nor does it lie in the plane of the orbit of the Earth, which is inclined to that of Saturn, and, excepting in

the two points where it crosses his orbit, has no reference to it whatever. But it is so placed as to make a considerable angle (26° 49′ 17″) with the orbit of Saturn, and while it is carried round the Sun with the planet, it remains always parallel to itself, since a fresh direction could only be the result of a fresh force impressed upon it from without; and no such force exists. Hence, in the course of one revolution of Saturn, or 29½ of our years, it turns first one and then the other side to the Sun; and in passing from the one to the other position, presents to him for a short time its edge, in which situation, from its extreme thinness, estimated by the American astronomer Bond at less than 40 miles, it will not reflect light enough to be visible at the distance of the Earth, without the greatest difficulty. But this is not the sole condition of the phenomenon, which depends not only on the position of the Sun, but of the Earth also: as the Earth is but seldom exactly in the line between the Sun and Saturn, it may so happen that the edge of the ring, when not presented to the Sun, may be turned towards ourselves, and then again its thinness will withdraw it from sight. And there is a third case of partial disappearance when the Sun and Earth are on opposite sides of the ring, and we look on the darkened side. This conjuncture is soon about to take place. May 18, the Sun passes from the south side, which we have been looking upon since February 1, to the opposite one out of sight from the Earth, and consequently its aspect will be entirely reversed from light to dark, with a singular corresponding reversal of visibility: the portion crossing the ball, hitherto undistinguishable on a bright background, will become strongly visible as a dark line of fully 2″ in breadth, and the extremities, previously so distinct against the dark sky, will disappear. After this epoch (May 18) the Earth's orbital motion carrying our eye towards the plane of the ring, the breadth of the dark streak will diminish; but not in a regular progression, for the Sun, gradually rising to a height of 1° 20′ above the ring, will cast a shadow upon the ball, which, increasing as the ring decreases, will keep in some degree the apparent breadth of the band. A few telescopes will be able, during this period, to distinguish the ring from its shadow, by bringing out a most delicate line of light between them; but they will be few indeed. It was seen by Dawes in 1848 with a 6¼ inch object-glass; but his eye is an extraordinary one. Schmidt also seems to have seen it in that year; and Jacob perceived it with an object-glass of 9 inches as recently as last December. This interesting series of phases will terminate on August 12, by the final disappearance of the ring as we pass to its enlightened north side, which will continue uninterruptedly in sight for nearly fifteen years; and fifteen years are

enough, compared with the short existence of man, to make us anxious to see all we can of this beautiful phenomenon, whose recurrence to us lies among expectations so uncertain in the far-off distance.

Were the ring symmetrical in all its parts and subdivisions, as we perhaps might have expected, this description would comprise all that would fall under our notice: the ellipse would close up into a line, and open out into an ellipse again, with mathematical precision. But such is not the case: there are anomalies, and like other anomalies they are, or may become, peculiarly instructive. As to the knotty aspect which the ring often assumes when reduced to extreme thinness, this, as Olbers pointed out long ago, is the mere effect of perspective foreshortening upon unequal degrees of illumination: the ring consists of concentric zones of different degrees of brightness; the ends of these, when viewed very obliquely, will expose the greatest amount of illuminated area, and in consequence of that irradiation which apparently enlarges all luminous spaces, in proportion to their brilliancy, at the expense of neighbouring dark ones, will appear to project like knots or beads upon the minute line formed by the fainter parts of the ring.* So far the explanation is satisfactory; and though these knots have been seen even when the dark side of the ring has been turned towards us, this has been accounted for by Bond, as the reflection of the Sun's light from the edges of the rings, which we might see through their interstices from beneath. But when we find the number of knots unequal on the two sides of the planet, as has often been noticed, and especially by Schröter and Harding in 1803, or when the two ansæ are unlike in length, or breadth, or continuity, or in the epoch of vanishing or reappearing, as in 1671, 1714, 1744, 1774, 1789, 1803, 1833, and 1848, we are obliged to infer some physical irregularity;—either the rings do not all lie in the same plane, or they have, as Schröter thought, mountainous prominences of great magnitude: the latter idea, singular as it may appear, is countenanced by the notched form of the shadow upon the ball which was several times seen by him, and since by Schwabe (probably) in 1848, by Lassell in 1849 and 1861, and by De La Rue also last spring. If this, however, is the cause, the rotation assigned to the ring by Sir W. Herschel from a moveable protuberance in 1789 must be abandoned, at least upon that ground, since his observation, never since confirmed, is contravened by the stationary character of these projections: rotation would not be incompatible with the idea of different planes;

* This appearance I witnessed with my 5½-inch object glass on February 7 and 8, and March 4, last, but best under inferior definition, any obscuring cause affecting the brighter less in proportion than the fainter parts of the line.

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but if we may credit the statements of a far inferior observer, De-Vico, who saw a lucid point adhering to the *opened* ring in 1840 and 1842, it can no longer be maintained upon any ground, and the ring must be considered fixed. How to account for its stable equilibrium and permanency would then be a difficulty indeed; for even with the powerful aid of rotation it has driven the American mathematicians (who have especially investigated the subject) from the old idea of solidity; Pierce taking refuge in the supposition of a fluid, and Maxwell in an aggregation of unconnected particles. The great Roman observer, Secchi, inclines to the idea of a gaseous or vaporous constitution. The faint visibility of the dark side of the ring, when it has been turned towards us, which was remarked by Herschel I. in 1789, and by Bond and Dawes in 1848, is an additional puzzle, especially the coppery tinge which was detected in it by the latter observer. It seems, from Bond's investigations, that it cannot arise from a twilight produced by an atmosphere surrounding the ring; nor is the direction of the Sun's rays favourable to the idea of a slight transparency, which otherwise its astonishing thinness would render very probable. Almost everything connected with this wonderful appendage seems at present involved in impenetrable mystery.

DOUBLE STARS.

Before offering to the reader a list of beautiful or interesting double stars,* we shall repeat what was stated at the close of the previous paper, that the possessors of even small telescopes will find many of them within their range, though of course limited apertures will detract from their brilliancy and distinctness. Admiral Smyth has assured us that the majority of the binary pairs may be reached with an object-glass of $3\frac{3}{4}$ inches in diameter, and that many of them may be beautifully seen with $2\frac{3}{4}$ inches; some of them he found distinctly visible with only two inches. Even the common little hand telescope, if good, may be turned to some account by any one who will adapt to it a deep astronomical eye-piece, and a small amount of skill in such matters will enable this to be done, and a suitable stand to be added, at a trifling expense. As an illustration of what might be effected in this way, I may mention that I have thus seen not only Mizar, but even Castor, of course in feeble light, but very well defined, with an object-glass of only $1\frac{1}{3}$ inch. It is possible indeed that with inferior optical means our first view may not answer our expectations; but the same great master, to

* See an "Introductory Paper on Double Stars," *Intellectual Observer*, p. 143.

whom we amateurs are so deeply indebted, will teach us that "many things deemed invisible to secondary instruments are plain enough to one who 'knows how to see them;' . . . . the eye itself improves, and the vision becomes sharper under practice, insomuch that the telescope seems to improve."

Assuming, then, that the student is anxious to make the best of his means, whatever they may be, we shall previously beg his attention to a few remarks which, in some cases at least, may be found of service.

No observer who hopes to see anything to advantage will think of stationing himself at a window, unless indeed his tube is long enough to carry the object-glass well out into the open air. Excepting at those seasons of the year when the external and internal temperature are equalized, the intermixture of warmer and cooler currents at an open window destroys all hope of distinctness with any magnifying power worthy of the name. It seems to be from this very cause on a large scale that the undulations and flickerings arise of which astronomers complain so much and so often. The success of Professor Piazzi Smyth's "Experiment" on the Peak of Teneriffe demonstrates how much the definition of our telescopes would be improved, could we leave the less equable regions of the atmosphere beneath our feet; but at any rate we need not artificially aggravate the evil which at our ordinary level we cannot avoid. The indistinctness thus produced is found to grow rapidly with increase of aperture, as indeed must be the natural consequence of including a greater amount of agitated medium in the cylinder of rays which the telescope brings to a focus; and hence the Roman astronomers who, even in that serene and pellucid air, find many a cause of complaint, occasionally contract the 9½-inch aperture of their noble achromatic to little more than five inches, in order to diminish the disturbance in less favourable nights. So far the possessors of smaller instruments are not without their advantage: they do not see so much, but they see more quietly, and they can employ a greater number of nights with tolerable comfort. The unsteadiness of a boarded floor is another argument for out-door observation. We are, generally speaking, scarcely aware how extensively vibrations may be propagated, even through materials of little apparent elasticity; but the shaking of the earth for many miles round an exploding powder-mill—fifty or sixty miles in the terrible Hounslow explosion in 1850—is a convincing instance of this; and when the celebrated optician Troughton used a small observatory in Fleet Street, during the two quiet hours—from 2h. till 4h.—in a London night, he used to perceive the approach of a distant carriage by the vibrations of a star in the telescope some considerable time before the slightest sound was audible. Hence,

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for accurate observations, instruments are mounted on the most solid piers of stone or brickwork, entirely insulated from the tremors of the surrounding floor; and hence the disadvantage of keeping the same boards under our telescope and ourselves. On all accounts, therefore, an outside situation is best; and we may be assured, from the almost universal experience of astronomers, that the much and very unjustly calumniated "night air" will work us no kind of harm. Of course, we shall use the ordinary precautions against catching cold; and our instrument will require equal attention, for object-glasses have a very inconvenient facility in catching dew. If brought uncovered suddenly into air of a very different temperature, this is pretty sure to happen, just as it does to a glass of cold water brought into a heated room; and in a dewy or frosty evening it will take place from radiation. The best mode of obviating this is to take off and ultimately replace the cap of the object-glass in the air in which it is used, and to provide it with a "dew-cap," a cylinder of pasteboard, light thin wood from a hat-box, or bright tin blackened in the interior, two or three times the length of its own diameter. On the removal of the brass cap, this should immediately be substituted for it, and remain till the last; and when the brass cap is about to be replaced, it will be advantageous to warm it previously. Where there is a finder it should be provided with a dew-cap also. If dew should have accidentally settled upon an object-glass, it is a good plan to unscrew it, and hold it before the fire; this will diminish the necessity of frequent wiping, which should be avoided, as the polish is very liable to injury; but the removing and replacing of an object-glass of any size demands a careful hand. After all, little specks will be formed in time, and occasional cleaning will be required; this may be safely done by dusting the glass with a camel's hair pencil, breathing upon it very slightly, and wiping it gently with very fine wash-leather, or a real silk handkerchief, both of which should be free from grit and dust, and kept for the purpose. Foreign glass will sometimes become discoloured even from the contact of loose particles which may have long lain upon it; no amount of friction will remove these stains which will not endanger the polish. If objects appear dim and foggy on a clear night, damp has, in all probability, settled on the surface of the eye-lens; this may be immediately dissipated by taking out the eye-piece, and holding it before the fire: the eye-piece of the finder is especially subject to this annoyance, as it is less frequently protected by the application of the eye: if the fire is not conveniently accessible, a bit of wash-leather may be kept at hand.

As no positive or Ramsden eye-piece (which has the plane surface of each of its lenses outwards) is achromatic, and even

Huygenian or negative ones are not always perfectly so, in estimating the colours of double stars the image should be kept in the centre of the field; for a similar reason such objects should never be examined near the horizon, when instead of a circular disc, they will show a coloured and flaring spectrum.

It may be occasionally advantageous to know the diameter of our field; this may be roughly estimated from the proportion it bears to the diameter of the moon, which may for very ordinary purposes be taken at half a degree. But it will be more satisfactory to note the time which a star near the equator occupies in crossing it; such as δ in Orion (the uppermost of the three in the belt); or γ Virginis (the method of finding which will be given under No. 10 in the catalogue), especial care being taken to make the star's passage as central as may be. The time thus given will be minutes and seconds of Right Ascension; these multiplied by 15 (since 15°=1 hour) will be converted into minutes and seconds of space, by which celestial distances are most usually measured. The reason of the employment of an equatorial star (a planet or the moon in the equator will answer equally well) will be at once apparent; the distance between the meridians, or hour-lines, decreasing continually as they recede from the equator, corresponds less and less with the same number of absolute degrees of space, which are always considered of the same value with those measured on that circle.

A general idea of the position of the meridian will always be of service; it may, of course, be obtained from a common compass, allowance being made for the declination of the needle, now amounting to about 21° W.; or from the gnomon of a good sundial, or from the position of the sun at noon by the dial, that is, uncorrected by the equation of time.

A few words may be added as to weather. With regard to wide double stars, which may be well seen with a low power, a choice of nights is not very important, the only essential point being that there shall be no haze capable of obscuring the smaller companions. But the matter is entirely altered when we attempt the separation of the closer pairs. Astronomers well know that a high degree of transparency may be combined with a most annoying amount of unsteadiness, and that what is called a brilliant night may hence prove perfectly useless for all delicate investigations; and thus we find Herschel II. speaking of such a night as "the worst possible for vision, though superbly clear." Higher powers becoming necessary as the components are nearer together, every atmospheric defect is magnified in the same proportion. At one time no care in focal adjustment will sharpen up the diffused blot to the semblance of a star; at another, the comparatively defined discs

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will be *rippled over*, as it were, as though they lay at the bottom of a rapid stream; at another, "flares" and distortions of various kinds and degrees will task the observer's patience, if they do not wholly frustrate his expectations. It is almost impossible to form a conjecture beforehand as to the prospect of a good night. Easterly winds have borne perhaps a heavier share of blame than they deserve; at least, I have noticed that when we have a *warm* breeze from the N.E., it usually brings sharp definition; and Herschel II. speaks of three nights of unexampled perfection (March 28, 29, 30, 1830), as ushered in by an east wind. His illustrious father states that dry air is unfavourable; frost sometimes favourable, sometimes not; thaw may be expected to be unfavourable, from the conflict of cooler and warmer currents. But, strange as it may seem, the unvarying experience of observers speaks stronger in behalf of a slight fog or haze, not, of course, for the detection of evanescent points of light, but for that steady definition which, with large apertures especially, is so seldom to be met with, and so very beautiful when it is attained. It would be easy to cite instances. Sir J. Herschel, speaking of March 28, 1830, says, "such a night for measurement I never witnessed, yet to the naked eye the stars are very dull (*stellis acies obtusa*), and no small ones (below 4·5 mag.) visible;" and the new dusky ring of Saturn was discovered by Bond, in America, in a sky so hazy that to the naked eye only the brighter stars were perceptible. Herschel I. states that vision is generally very perfect in windy weather; but a very steady stand will be necessary to avail ourselves of it. In the winter, his son tells us that distinct vision often comes on an hour or two before midnight. It is a singular fact, but attested by the concurrence of many observers, that a twilight sky is often favourable to the definition of difficult objects; the spurious discs seeming to be diminished upon a brighter background.

The objects in the following list are numbered for convenience of reference, but no regular arrangement has been adopted; the easiest and most instructive take the lead, but any stated classification would be too much complicated with considerations of absolute and relative magnitude and distance, and would have to be subordinated after all to the season of observation, which will cause the postponement of many pairs otherwise entitled to precedence. For the student's convenience the present series has been restricted to objects visible with the naked eye, and in easily recognized positions, as well as within the reach of ordinary telescopes; the directions given for finding them will probably supersede the use of maps; but should such illustrations be desired, the Larger Star Maps of the Society for the Diffusion of Useful Knowledge, sold by

Stanford, Charing Cross, can be strongly recommended, both for accuracy and extraordinary cheapness. Their chief defect arises inevitably from the attempt to represent a sphere by a cube, so as to comprehend the whole in six maps; in consequence of this the corners become very much distorted, and the squared-out degrees of the centre are there transformed into a kind of lozenge-shape; this must be carefully borne in mind in comparing those parts with the heavens. A Moveable Planisphere, by Smith, Strand, is also spoken of as very useful in showing the principal stars above the horizon at any given time.

We may now proceed to our little working catalogue.

1. *ζ Ursæ Majoris. Mizar.* Distance 14″·4. Position 147°·4. Magnitudes 3 and 5. Colours, white and pale green. Struve makes them both greenish white. Relatively stationary, but probably with common proper motion. There are several reasons why this star may properly head the list. It is very readily found, being the sixth in order of the seven stars of the Great Bear, or the centre one of the tail; it is at a sufficient height above the horizon during the whole year (though unfortunately rather awkwardly elevated during the spring months); it is within the grasp of very small instruments; and from its association with a third star, called Alcor, bright enough and distant enough from the irradiation of its neighbours to be visible without a telescope, it furnishes a peculiarly apt means for training an untutored eye. Amateurs may be expected to have at first confused and inadequate ideas of magnifying power; and those who have never before viewed double stars with the telescope will sometimes even imagine that they can distinguish them without it, though it is found that, for this purpose they ought, generally speaking, to be four minutes of space asunder, a distance from eight to eighty times greater than that of the generality of stars in the present list. Another source of mistake may be that the great increase of brightness in the telescope does not render itself at once intelligible to the inexperienced eye. Erroneous impressions from these causes may be effectually corrected by means of Mizar and Alcor. Let these two be alternately viewed, in and out of the telescope, a low power being used to include Alcor in the field, and the inversion in the instrument being borne in mind; and it will be readily perceived how great is the effect of magnifying power in separation, as well as of aperture in increasing brightness. It will be at once seen that no unaided eye could possibly separate Mizar into its components, and the idea will never be revived of the possibility of distinguishing double stars without the telescope, excepting under circumstances of unusual distance.

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Alcor is of the fifth magnitude, and is distant 11′ 30″ from Mizar. It is known as the "rider upon the horse;" the middle one of the team of three, in the figure of Charles's Wain, as Ursa Major has been popularly called in this country. This name must be very ancient, long before Shakespeare's time, for we find from Admiral Smyth that it is familiarized from the Gothic Karlwagen, the *charl* (*ceorl*, Saxon) or peasant's cart. Alcor seems to have formed a trial of sight among the Arabians, according to their proverb, "Thou canst see Alcor, yet canst not perceive the full moon;" they gave it also the name of Saidak, the "test"; and hence Arago thinks a change may be inferred, as it is now so readily visible: it was also known amongst them, as the Admiral tells us, by the term Suhà, and implored to guard its viewers against scorpions and snakes; why, it does not appear.

Mizar seems to have been a strange stumbling-block to observers in the last century; and for no intelligible reason, as it is so easy an object. Its duplicity was discovered by Riccioli, nearly in the middle of the seventeenth century: it was again noticed in 1700 by Gottfried Kirch and his scientific wife, Maria Margareta, who was subsequently, in her widowhood, astronomer to the Academy of Sciences at Berlin: and it was observed double by Bradley in 1755: yet Flaugergues used to try his telescopes upon it about and after the year 1750, without perceiving the companion till 1787: and even then he fancied that the pair gradually widened to three or four times its original distance; which, as Smyth remarks, "must have been merely the effect of becoming better acquainted with the object before him." Even such men as Delambre and Mechain have been suspected of overlooking the smaller star: and there is a strange story told about Mädler at Dorpat as recently as 1841, when, on observing this star by day, he was astonished to find it single; he waited till after sunset in vain, perceiving in the meanwhile distinctly several other pairs difficult to be observed in twilight; but, within an hour afterwards, he found it double in all its splendour. One is tempted to think that he must have been previously looking at the wrong star, but he does not seem to have suspected this himself. The Roman astronomers in 1842 described an imaginary *comes* lying nearly between the two stars; but this was not their only blunder of the kind. Their telescope—a very fine one, with a 6½-inch object-glass by Cauchoix, had this imperfection, and they, unfortunately for their reputation, published its defects as discoveries. Sestini, De-Vico's assistant at Rome, gave the colour of the smaller star yellowish with the Cauchoix telescope. Admiral Smyth has republished in his Ædes Hartwellianæ, a detailed comparison of the colours of 109 stars as noted once by Sestini, and

twice by himself and his friends. The discrepancies are occasionally very strange, and some of them will be given in our present list; but, on the whole, many of the Italian observations *of that date* seem more valuable as illustrations of individual peculiarity than as evidences of fact.

It has been suspected that Alcor, together with Mizar and its companion, may be mutually connected as one grand ternary system. Several minute stars will be found in the field, the largest of the eighth magnitude. Mizar has of late years been photographed no less than 86 times with the great achromatic of $14\frac{3}{4}$ inches aperture at Harvard College, U.S., in order to measure the image instead of the object—a much more convenient process, which seems to promise some great advantages.

2. *a Ursæ Minoris. Polaris.* 18″·6. 210°·1. $2\frac{1}{2}$ and $9\frac{1}{2}$. Yellow and dull white. So Struve. Sestini and Dawes make $9\frac{1}{2}$ blue, and so I have thought it. This is the *Pole-star*, so called, not from its occupying the polar point, from which it is distant about 1° 25′, or somewhat more than $2\frac{1}{2}$ diameters of the sun, but from its being the nearest to it perceptible by the naked eye. The mode of finding it by a long line passing through the Pointers, or right hand stars of the Great Bear, is well known, and once found it will not be lost, as it stands comparatively alone in a wide space. The *comes* has long been referred to as a test of the goodness of small glasses. It was formerly proposed as a standard of eyes and instruments by Dawes, who considered that in most instances two inches of aperture would be scarcely sufficient to show it steadily. Smyth, however, saw it distinctly with his $5,\frac{9}{10}$-inch object-glass reduced to that size. The celebrated Dorpat achromatic of $9\frac{1}{2}$ inches exhibits it even while the sun is above the horizon, and Kitchiner saw it with a power of 18 applied to a 7-inch object-glass by the elder Tulley. In the case of minute points which approach the *minimum visibile* in a telescope, the device of *oblique* or *averted* vision, by which the image is made to fall on a more sensitive part of the retina, will often give the first intimation of their existence; and when their position is once known, they frequently become much more perceptible.

Polaris seems to be merely an optical pair, their proximity being the effect of perspective alone, and their real distance being incalculable and incomprehensible. We shall find, however, as we proceed, that magnitude is a much less safe criterion of distance than was supposed in former days.

A small amount of parallax has been ascribed to the large star. If correct, it shows a distance which light, reaching us in $8\frac{1}{4}$ minutes from the sun, would not traverse in less than *thirty years*.

3. *a Ursæ Majoris. Dubhe.* 6′ 20″·6. 203°·8. $1\frac{1}{2}$ and 8.

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Both yellow. I have thought 8 violet with a $3_{1}^{7}{}_{0}$ object-glass, lilac with 5 inches. This is the most northerly of the Pointers. It is a very wide object, and of little scientific interest; but it appeared to me of sufficient beauty to merit insertion, especially as the yellow hue of the large star is very fine.

4. *a Geminorum. Castor.* 4″·7. 258°·8. (1830·95). 4″·9. 248°·1. (1849·17). Fletcher found 5″·309. 245°·66. (1857·28). 3 and $3\frac{1}{2}$. Bright and pale white; greenish, according to Struve; greenish yellow and greener, Dembowski. This is the most northerly of the two large stars which mark the heads of the Twins, and which will be found declining towards the W. at the beginning of May. Castor is an intrinsically glorious pair, and especially interesting as being, in Sir John Herschel's words, "the largest and finest of all the double stars in our hemisphere, and that whose unequivocal angular motion first impressed on my father's mind a full conviction of the reality of his long-cherished views on the subject of the binary stars." That it is binary—a superb system of two neighbouring suns, there can be no doubt; but there is some difficulty in ascertaining its period, although it has been watched from an earlier epoch than most objects of this kind. Sir J. Herschel has assigned 253 years, Smyth 240; the result is not entirely satisfactory, but of the revolution round a common centre of gravity there is no doubt. "This," as Admiral Smyth says, "is a great fact, and an astronomical revelation which, in all probability, Newton himself never contemplated." In the case of undoubted binary pairs, more than one of Smyth's epochs will be given as above, for comparison. The earliest observation, that of Bradley and Pound in 1719, made the angle 355°·53; a very little experience in estimating positions will show how great has been the intermediate change. A power of 80 should bring out this pair well. I have divided it with 55, and an aperture of $5\frac{1}{2}$ inches.

5. *ζ Cancri.* 5″·4. 149″·4. (1832·23). 4″·8. 144″·1. (1853·17). 6 and $7\frac{1}{2}$. Both yellow. Sestini makes the small star white; yet he calls Castor yellowish and yellow. This easy double star is apparently in slow motion, in an orbit of possibly 500 or 600 years; none but very fine telescopes are now capable of showing, what was more easily distinguishable twenty years ago, that the larger star has another of seventh mag. almost in contact with it. A very fine five feet achromatic may possibly detect some elongation. This close pair is in rapid motion, but with a period as yet undecided; and the whole triple combination, if such it be, with all its intricate relations and movements, is a truly wonderful object. To find it, run a line from Castor through Pollux, and continue it between two and three times the distance of those stars; it will pass a little above ζ, when W. of the meridian.

A little to the E., somewhat N., of ζ, and consequently just above it, as it declines towards the W.,* lies the famous cluster *Præsepe*, visible to the naked eye as a nebulous spot. It scarcely comes within the scope of the present list, belonging rather to the class of Groups and Clusters, of which it is one of the most conspicuous. However, as we are so near to it, we shall probably feel disinclined to let it pass. Our lowest power will be required to enlarge the field, and comprehend at once as much as we can of this magnificent cluster, which, after all, will probably much exceed our limits.

6. *ι Cancri.* 30″·1. 307°·8. 5½ and 8. Pale orange and clear blue. Herschel I. made the smaller deep garnet, 1782, February 8; bluish, December 28; blue, 1785, March 12. Relatively stationary, but there seems to be a common motion in space. A beautifully-contrasted pair, in which, as usual, the hue of the larger component is taken from the less refrangible end of the spectrum, an arrangement too general not to indicate the footsteps of some unknown law. To find it, a line is to be drawn from Præsepe to Polaris, bearing a little to the left; where another line passing between Castor and Pollux would intersect the first at right angles, we come upon this star, which, though not bright, is the most conspicuous for several degrees around.

7. *ϵ Hydræ.* 3″·4. 198°·4. (1837·11.) 3″·6. 203°·2. (1843·14.) Fletcher, 208°·52. (1852·96.) 4 and 8½. Pale yellow and purple. The small star in this beautiful object was missed by Herschel I., and Dawes therefore suspects that it may be variable. Struve discovered it, and his measure confirms the idea that it may be in orbital motion, with a possible period of 450 years. It may be found thus:—a line drawn from Polaris through Pollux, will fall upon Procyon, a 1st magnitude star in Canis Minor. Another line carried from Procyon to Regulus passes just above a little group of stars, rather nearer to Procyon of the two, marking the head of Hydra. The most northerly of these is ϵ.

Here we suspend for the present our selected list of double stars, proposing to resume it in our next number, together with other matter of special interest during the month.

* The student may be reminded that N., S., E., and W. are always understood as expressing the bearings of objects *when they are on the meridian*, and that, in proportion as they are removed from it, they cease to be synonymous with *above, below, to the left or right.*

HAUNTS OF THE CONDOR IN PERU.

BY WM. BOLLAERT, F.R.G.S.

THERE are three routes by which Iquique, the scene of the following adventures, may be reached. The first, and most general, at the period adverted to (1826), was by "doubling" Cape Horn, and then pursuing a north course in the Pacific; the second, by the River Plata, braving its fierce pamperos, taking a gallop of a thousand miles over the pampas to the once smiling Mendoza—lately destroyed, with nearly all its inhabitants, by a fearful earthquake—making the passage of the mighty Andes, descending to Chile, and embarking at Valparaiso for the coast of Peru; the third, which is the one now usually followed, is by steamer from Southampton to the West Indies, and across the Caribbean Sea to Colon (a distance of about 4800 miles) the Atlantic port of the Isthmus of Darien; here we find a railroad forty-eight miles in length, over which one is whisked, through one of the most beautiful, natural, and tropical gardens in the world to the city of Panama. Off you go again, by steamer, towards the south, crossing the equator, and if not cloudy you may get a peep at Chimborazo, and remain a couple of days at Lima, founded by Pizarro, and where he was assassinated, and long celebrated as the "heaven of women, purgatory of men, and 'other place' of jackasses"—the meaning of which is that the Limeñas are beautiful, the men are enslaved by them, and the donkeys cruelly cudgelled by their negro drivers.

Leaving Callao, the port of Lima, you pass the considerable ruins—more ancient than Manco Capac and his dynasty—of the city and temple of Pachacamac, built by rulers called Curysmancus, the last of whom were conquered by the later Incas; you look in at the Chincha Islands, from which so much guano is extracted, and may get a peep at the volcano of Arequipa. You continue along a high arid coast, seldom or never watered by the slightest shower of rain, and steam through a most pacific sea, which, during the hot summer months, looks like a saline, half seething cauldron.

In latitude 20° 12′ south and 70° 14′ west, you arrive at Iquique, now well known as being the principal port for the shipment of nitrate of soda, which is found in very great quantities a few leagues up the country, on a table-land 3000 feet above the level of the sea. It is the principal harbour of the province of Tarapaca. In 1826 it contained only a few fishermen and their families; it now shelters a population of 5000 souls, and according to recent accounts could boast of an Italian opera, although it is situated on a complete saline,

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Haunts of the Condor in Peru.

shelly, and sandy desert. No fresh water can be got by digging, so water for drinking is distilled from that of the ocean, and food is supplied principally from Chile. The history of this place—its hospitality, customs, and manners—would make a curious and interesting chapter, the more particularly as its rapid growth has been the consequence of the discovery of nitrate of soda in the adjacent region.

The writer of the present paper, with his old and valued friend, Don Jorge, when there, in 1826, superintending the working of a silver mine at Huantajaya, were the only foreigners in the province. These mines, like the majority in this district, are in the desert mountains of the coast, at an elevation of from 3000 to 6000 feet high, where there is neither moisture nor vegetation. Water had to be brought to them from a distance of thirty miles, in bags made of sheep-skins; and this journey through a broiling sun did not tend to increase the palatableness of the liquid.

Water for the use of man being so scarce, it was at times next to an impossibility to allow it to animals; and the writer has often had to trudge on foot from Iquique to Huantajaya, which, although only seven or eight miles, is a most fatiguing journey, over a burning plain, up a wearisome sandy ascent, along the base of the high escarped mountain range, and finishing with a grand tug up the "caracol," or zig-zag road, the summit of which is nearly 2000 feet above the level of the sea, with yawning chasms and jagged peaks on either side. The track then goes along a most desolate-looking route, covered with patches of salt in cakes and nodules, and sun-incinerated stones; and to the left, among other ranges, is that of the silver mountain of Huantajaya, sometimes called the Potosi of Peru.*

The silver produced from 1726 to 1826 was worth about fifteen millions of pounds sterling. Since 1826, and in consequence of labour being diverted to the extracting, refining, and carrying the nitrate of soda to the coast, the annual yield has fallen to about six thousand pounds. The mines of Santa Rosa, within sight of Huantajaya, have likewise afforded considerable supplies of the same metal.

The ordinary route from the mines down to the coast is not difficult, most of it being an easy descent; but there is a "short cut" by the Lomas of Guantaca, and very much steeper than the other. It was by the former that Don Jorge and myself arranged to go to Iquique, our object also being to explore the country and behold the reported "panizos," or indications of metallic veins in the mountains.

So, one morning, each with his *alforjas*, or saddle-bags, containing a gourd full of water and some "provend," slung

* The original Potosi is in Bolivia.

over the shoulders, Don Jorge with his sketch-book, myself with geological hammer and chisel, we sallied forth from Huantajaya, a town built of *caliche*, or salt and earthy matters found on the surface, and supplying the readiest material at hand. Not the slightest vegetation was to be seen—it was a very picture of utter desolation.

Journeying up the ravine of San Guillermo, we halted to survey the old silver mines and ruins of Coronel, and the thick beds of a kind of fossil oyster shell, at nearly 3000 feet above the sea—the silver veins having apparently pierced this ancient mass of organic matter. Then followed a couple of hours more trudging under a burning sun and cloudless sky, up and down, and crossing ravines, and along sandy *laderas* or sides of mountains, stopping to examine here and there the protruding edges of silver veins, and wondering how so much salt, generally in nodules, could have got there. The unlearned said it had been left there when the sea retired from the land. This is improbable; but after some research in these regions it would appear to the writer that the great quantity of salt, which is on the surface only, is most likely formed by infiltration from the Andean regions, where he has seen interminable salt plains at 14,000 to 15,000 feet above the sea. He has succeeded in tracing the salt percolation downwards to a lower country, say to 3000 feet above the sea, the saline waters keeping near the surface, and containing, in addition to the chloride of sodium, boracic, iodic, chromic, and other salts.* This saline water has been met with in one of the mines of Huantajaya.

Salt was then found in such quantities that ship loads were taken from the vicinity of the silver mines of Santa Rosa, and thirty years afterwards there was another crop on the same ground. One proof that this salt is not of oceanic origin is, that it is nearly a *pure chloride of sodium*, and as it appears to be brought by infiltration from the Andes, it may claim a volcanic origin by the direct combination of chlorine and sodium.

We will rest awhile, take a little bread and *charqui* (sun-dried beef), a draught of water, and a cigar, in the ruined *corales* of Guantaca. These *corales*, or enclosures, had been used by the Indian fishermen of the coast when out hunting

* Nitrate of Soda.—In 1830 only 900 tons were exported, but in 1859 there were nearly 79,000 tons. In 1860 it was calculated that there was some 63,000,000 tons of native nitrate on the ground, so that at the present rate of extraction it would take about 1400 years to work it up.

It would appear that common salt brought down by ravines and percolation from the Andes, in process of time undergoes nitrification, being now in company with lime and the nitrogen of the air, by a process at present not easily explained —the chlorine of the sodium going to the lime, forming chloride of calcium, and a nitrate of soda being produced.

huanacos, which, during the spring months of these regions, called by the natives "El Tiempo de Flores," roam about in search of the spare pasture occasionally found on the summits of the mountains of the coast. This peculiarly-placed vegetation—constituting the flower-spots of the desert—consists of some twenty to thirty species of plants, many of them small bulbs producing white and blue flowers. There is also much of the oxalis, and some gigantic cacti, thirty or forty feet high, and ten or fifteen in girth, with yellow blossoms.

The morning breeze had died away, and the scorching sun was in its zenith, when we commenced the ascent of the steep ravine of Guantaca, deeply strewed with angular stones, formed by the breaking away of its rocky walls, which are composed on one side of granite and on the other porphyry. On the granitic side of this sombre and melancholy-looking spot, grew here and there the gigantic cactus trees of the kind just mentioned; and at their bases lay small heaps of dead bulimi, whitened by exposure, and on the leaves others in a live state, with shells of a brown hue; there were three or four species of them. There were no cacti on the porphyritic rocks; and the greater fertility of the granite arises from its containing so much soluble alkali as to be more easily decomposed by the dews at night and the intense heat of the sun during the day, and thus affording a comparatively nutritious material for the plants —soil it can scarcely be called.

The stillness of the scene was most impressive; all that we heard was our tramp over the track, and now and then the slight chirrup of a little slate-coloured bird, the "come sebo," or fat-eater.

Instead of continuing our course up the ravine to its pass, and then descending by the ordinary track to Iquique, we bore off to the right, picking our way over and through masses of granitic rock for a considerable time, not with the intention of making a "short cut," but to explore the "Lomas," or summits of the mountains of the coast. This we did to our heart's content, having traversed a district probably never before visited by a white man.

From some of the passes and summits we had a glorious view of the wide expanse of the Pacific Ocean; from our elevation and proximity we appeared to be looking into it, not along it; and the horizon being on a level with the eye, appeared like a line almost within our grasp. A little to our left stood Iquique and its guano island, which we could see as if it were in plan, and two small guano vessels in the offing were at such an angle that we thought we could perceive the very decks.

After feasting our eyes upon so peculiar a sight, we medi-

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tated about our descent to Iquique, which we anticipated would be rather amusing, for it was sure to be steeper than the Guantaca track. Having had some experience in clambering about the badly-worked mines of Huantajaya, we imagined ourselves fit for any emergency. Now and then we called out to one another, "Take care;" "Mind that piece of rock you are standing on, it looks rather loose;" or, "That lump of rock above does not want much of an earthquake-shake to send it down;" for earthquakes are almost of daily occurrence in that region. Onwards we went, having to pick our way with the greatest caution; above us were the rugged peaks, below us the abrupt declivity going down to the very ocean. Had giddiness seized us, and caused a false step, it would have been our last.

My companion was in advance, and as he had been to sea in his younger days, he had a better knack of balancing himself whilst progressing and springing over bad places. At length this *paseo*, or ramble, began to tire us, and although Iquique appeared as if at our feet, we were not in a position to make anything like a straight course to it; and, after a little time, we got into a most awkward position, as the mountain became much rounded on the steep descending slope; our footway was of decomposing granite, which we felt had only to be heavily trod on, and then away would slide down a portion of the coating of the hill. Occasionally pieces of rock would fall, and the way they made their descent showed too plainly how we should go if we fell.

Our course became worse. I was brought to a stand-still and not being able to ascend or descend, was obliged to poise, myself most carefully. I now commenced cutting foot holes, working myself round a projecting bluff, when I came in sight of Don Jorge scrambling up to a withered cactus, astride of which he got, so as to take a rest. He soon shouted, "Look out, Don Guillermo, here come a lot of condors, we must take care of ourselves." I looked up and around, and sure enough I saw the condors whirling round in circles, the circles getting smaller as they approached us. Other condors were in the distance, all apparently of the same flock. They had doubtless seen us for some time from one of their look-outs, probably the Morro of Tarapaca, about nine miles off, in a straight line, and some 3000 feet higher than we were.

Two of the largest of the condors would approach at intervals, in rather too close a proximity to my friend, when he would shout his loudest, and bang stones at them, sometimes hitting our enemy; this seemed to astonish the birds, and we could see them gently shake their wings.

I had some hovering about me, but one kept itself in a line, as if it intended to come butt up against me. These were

fearful moments for us both. I could observe Don Jorge's exposed situation, and that, if the decayed branch of cactus gave way, he would be hurled down and dashed to pieces. As to myself, he could see that a portion of my body was projecting over a precipice.

I stood on the defensive, with the geological hammer in my right hand, whilst my left was stuck in a hole in the loose granitic stuff for support. If I had been compelled to have struck an assailing condor with my hammer, the chances were that such a movement would have dislodged me, and down the rock I must have gone. I had previously, and have since, been in personal "difficulties," but never so near being rolled down a precipice, dashed to pieces, and made food for condors.

Whilst this skirmishing was going on, my companion cried out, informing me that at the bottom of the not very deep break that separated us, there was a collection of sand, and the only way of extricating ourselves from our present perilous situation, was to do our best and jump into the sand below. Once there, we should be a better match for the condors, pelt them at our ease, and then see who would have the best of the fight.

Watching an opportunity when his assailant had veered off a little, he left his somewhat uneasy position on the cactus, which still retained a quantity of its spines, took a jump, and landed without broken bones on the patch of sand beneath.

I now left my cramped and awkward berth, putting myself into a jumping attitude, whilst Don Jorge stationed himself below so as to break my fall. I took the leap, or rather a sort of flight, coming lengthways upon my face, sliding some distance down in the sand. Thankful, indeed, were we, that we had been thus protected from an untimely death.

Once on the sandy spot, we sat down, and could observe without fear the bold and graceful whirling course of the condors, and when any of them darted out of their circle of flight, to approach us, we could pelt at them; although few if any of our missiles reached them. We watched and pelted at these kings of the feathered tribe, until they concluded that we were not designed for their consumption, and slowly drew off in the direction of the Morro de Tarapacá, where doubtless they had their resting-place during their visits to the coast, and from whence they could, with their wonderfully far-seeing eye, scan on the desert tracts below, carrion, in the shape of a dead mule, or ass, or the body of a defunct whale on the sea-shore.

It is hoped that the scenes I have attempted to delineate will assist my readers in picturing the condor at home. The wild creatures of the forest or the desert cannot be understood and appreciated if severed from their natural surroundings; and now that I have endeavoured to show the character

of their haunts, I may be permitted to add a few particulars which I collected while residing in their vicinity.

The condor, or *Sarcoramphus gryphus*, the huitre of the Spaniards is one of the largest of the vulture tribe. Its breeding places are in the Andes of South America, at great elevations. Its food is carrion, but it will attack lambs and goats, or the young of the llama genus. Two, it is said, will fight a llama, a heifer, or even a puma. In Chili they are known to roost on trees, when the guasso, or countryman, climbs up and lassoes them. It is reported that the condor makes no nest, that the female lays two large white eggs on a bare rock, like most raptorial birds, and the young are unable to fly before a year.

Tschudi, who had good opportunities of studying the habits of this bird, tells us that it hatches its young in April and May. The full-grown bird measures, from the point of the beak to the end of the tail, from 4 feet 10 inches to 5 feet, and from the tip of one wing to that of the other, 12 to 13 feet. When flying it cannot carry a weight of more than eight to ten pounds.

The condor passes the greater portion of the day in sleep; hovering in quest of prey chiefly in the morning and evening. While soaring at a height beyond the reach of human eye, the sharp-sighted bird discovers his quarry beneath him, and darts down upon it with the swiftness of lightning. Tschudi kept a young one at Lima, and to prevent its escape, when it was able to fly, fastened a chain to his leg, to which was attached a piece of iron of six pounds weight. When it was a year and a half old, it flew off with both chain and iron, and perched upon the spire of a church, whence it was scared away by the carrion hawks. On alighting in the street, a negro attempted to catch him, upon which the bird seized the negro by the ear, and tore it off. The condor then attacked a negro child of three years old, threw him on the ground, and knocked him on the head so severely that the child died. This bird died on his passage to Europe.

The writer's first acquaintance with condors was in Chile, in 1825, whilst hunting the puma in the Cordillera, above the hot baths of Colina. Thereabouts this fine bird may often be seen descending from the Andean regions, hovering in the air, and on the look-out for dead cattle. In Peru, they range from the sea-coast to an elevation of 16,000 or 17,000 feet in the Cordillera; the writer particularly noticed them when he ascended the Andean peak of Tata Jachura, in the province of Tarapacá, with his friend Don Jorge. This peak is 17,000 feet high at least. His next meeting with them was in the attack at Iquique, and he has since observed them in the desert of Atacama.

It is generally asserted that condors are only seen in groups of three or four, but never in large companies, like vultures. This is hardly the case, for in our narrative it may be observed that the attack was made by a rather large flock of them. In 1854, the writer saw a group of fifty condors, near the *Caracol*, or zig-zag road at Iquique. He was also informed that a hundred or more may be seen hovering over the cattle estates in Chile. In 1820-3, when there was whale-fishing off Coquimbo, the offal would float on shore, and as many as two or three hundred would collect to gorge on the remains. I was once exploring with Don Jorge the mountain of Molle, near the nitrate of soda works of La Noria, on the summit of which there is an abandoned silver mine. Having entered it to rest and get out of the intense heat of the sun for awhile, we very soon had to make our exit in consequence of becoming thickly covered with what we afterwards learnt were the lice of the condor. Such a locality is called their *alojamiento*, resting-place, or look-out. On another occasion, exploring some high mountains overlooking the great saline table-land of Tamarugal, and where the newly-discovered salts of borax exist, we came upon another condor *alojamiento*, on an exposed rocky crag, but here we only observed a collection of their ordure. It is from such a spot that the condor watches for dead and dying mules, on the tracks to or from the various *oficinas* or nitrate works.

I once observed a young condor perched on the sore back pecking at the wound of a mule who had just strength enough to slowly crawl along. I drove the bird away, and shot the mule.

In 1852, whilst Don Jorge was travelling from Iquique to the Noria, a condor fell from a great height, just before him and his party, and was quite dead; had it fallen on any of them, the individual must have been unhorsed and bruised.

It might be expected that such a remarkable bird would make its appearance in the local mythologies, and we find that the worship of the condor, together with that of serpents, and other animals, was celebrated in the early times of Peru. On the pre-Incarial monuments of Tia-Huanaco, situated to the south of Lake Titicaca, are sculptured the heads of large birds, most probably intended for the condor, and likely to have received the adoration of the builders of those most ancient remains.

XUM

M. FAYE ON SOLAR REPULSION.*

It follows from a consideration of all the facts relating to the acceleration of comets, and of the forms they assume, that there exists in celestial space a repulsive force, exeertd by the surface of the sun; that this force is due to incandescence, and operates like attraction at all distances. The physical phenomena which surround us afford striking indications of a force of this nature, and we can put them in evidence by causing an incandescent surface to act under the conditions which are revealed to us by the study of astronomical effects. There is thus an identity between the two forces which have their origin in heat, just as there is an identity between celestial attraction and terrestrial attraction, as shown by the fall of heavy bodies in the celebrated experiments of Maskeleyne and Cavendish. But repulsion exerted at a distance by an incandescent surface cannot be a different thing from the molecular repulsion which is equally due to heat, the force to which physicists attribute the phenomena of dilatation, of changes in the state of bodies, and their elasticity in the gaseous form. We arrive, then, at the conclusion that there exists in nature a force not less general than attraction, and which, like attraction, manifests itself in celestial spaces as well as in molecular intervals.

There is, however, a difficulty which seems to oppose this complete identification. The molecular repulsion due to heat has always been considered as a force which disappears at any appreciable distance from its centre of action, and it has this character, whether we admit with Newton an interruption of continuity, or prefer to have recourse with Laplace to the remarkable hypothesis of forces whose sphere of activity does not extend to sensible distances. . . . . Laplace thus expresses himself on this subject. After having calculated the pressure in a gaseous mass, bounded by a spherical envelope, in accordance with the hypothesis of a repulsive force with an indefinite sphere of activity; he shows that the law of repulsion adopted by Newton is far from representing the conditions which this constant pressure exhibits, and he then remarks, "This great geometer does indeed assign to this law of repulsion an insensible sphere of activity; but the manner in which he explains its wants of continuity is little satisfactory. We must, without doubt, admit a repulsive force between the molecules of the air, which is only operative at imperceptible distances. The difficulty consists in deducing from it the laws of elastic fluids, and this can only be done by the following considerations." These considerations take for their point of departure, the formulæ

* Translated from the *Comptes Rendus*, 10th March, 1862.

by which the mutual attraction of spherical bodies is determined, and a simple change of sign enables us to pass from a case of attraction to one of repulsion.

No one will deny the necessity for this narrow limitation of the sphere of activity assigned to molecular force, but must we therefore conclude with Laplace that it is a special force, distinct from the great forces of nature which operate at all distances? No. It is easy to see that the repulsion due to heat, and defined by its astronomical characters, exhibits precisely the phenomena of forces with an insensible sphere of activity, although in free space it operates at all distances. That which conceals the true explanation, is that our minds, for a long time habituated to speculations on Newtonian attraction, experience a difficulty in considering forces of a totally different nature, and if we speak of repulsion we conceive of it only as an attraction with a change of sign, and philosophers like Bessel only see a negative attraction in the repulsion so visibly exerted by the sun. But it is not so; solar repulsion as exhibited in the movements and figures of comets, differs widely from a negative attraction, first by its successive propagation, and secondly, that it does not pass through matter as the attractive force does. It is in this last characteristic that we find the key of the difficulty, and it is in harmony with all the evidence collected in my researches, and on which I have had to insist so often during the last three years. For if we consider the essential character of the repulsive force we shall easily perceive that it assumes in all bodies the conditions of a force with an insensible sphere of activity. Each molecule of a body is in fact surrounded, at an inappreciable distance, by other molecules which receive its repulsive influence, and at the same time behave to it like a screen. And as these molecules are not mathematical points, and as their dimensions are considerable when compared with the intervals which separate them, the repulsion due to heat—an action of surface, exhausting itself on the surface of the body which it affects—will find itself sensibly reduced beyond the limits of the molecules surrounding each centre of action. We may further conceive that the radius of this boundary, that is to say, the sphere of activity of each molecule, may be equal to a definite number of times the interval between the several molecules, and thus, belonging to the same order of minute magnitudes as they do, may be equally inappreciable. To this remark M. Faye adds in a note that instead of being an absolute quantity this radius may depend upon temperature, and then he observes: Thus the repulsive force which acts at all distances in celestial spaces, finds itself reduced in the interior of bodies to an action at insensible distances, and consequently in all that concerns the mechanical action of heat, a

XUM

special hypothesis, like that of Laplace, is useless, as everything is explained on the supposition of a force distinct from Newtonian attraction, but not less general in its operation. Is it not remarkable that we have had to seek in the heavens for the essential characteristics of the two great forces which govern the material universe?

HYBERNATION OF FUNGI—THE GENUS SCLEROTIUM.

BY THE REV. MILES JOSEPH BERKELEY, M.A., F.L.S.

Up to a very recent date the science of Mycology was overlaid by a host of spurious genera and species, destitute of every trace of fructification, and often of most uncertain origin and affinity, and in consequence quite unworthy of admission into any arrangement professing to be natural. The eyes of one or two first-rate mycologists were first well opened to their true character about forty years ago, when Fries propounded the wise rule that no fungus should be admitted into the system whose fruit was wholly unknown, or whose affinities were so doubtful, that the nature of the fruit could not be readily divined. He did not indeed always keep himself to his own rule, and perhaps it was impossible for him, at that time, to do so, but the great host of mycologists, whether of greater or less consideration, instead of profiting by his advice, still clung to their own "mumpsimus" and burdened science with multitudes of *Himantiæ*, *Rhizomorphæ*, and other equally imperfect organisms. It was easy enough, indeed, for any one who was inclined to make use of his eyes, to see that many of these were merely the spawn of various fungi, in imperfect conditions, or arising from abnormal places of growth. A morning's search after fungi in our woods and forests could scarcely fail to convince one that many a white *Himantia* was due to the common species of *Marasmius*, which occur on oak leaves, or to some well-known Agaric, such as *Agaricus dryophyllus*, and as little could it escape notice that *Phlebomorpha* was merely the early condition of some *Trinchia* or allied genus. Still such genera were retained by authors with the utmost tenacity, and perhaps for one reason amongst others, that they were easy to recognize by some empirical process, without any of the difficulties which almost always attend the precise determination of genuine species.

Though Fries, with that peculiar tact which has characterized his career as an observer and has assigned him one of the highest

places amongst modern botanists, was eagled-eyed about the greater part of these spurious productions, with one or two exceptions, the most prominent of which will be noted presently, he was strangely misled by Unger and others as to the nature of those rust-like parasitic fungi which grows on living leaves, and constitute one of the greatest scourges of the cultivator. Though in reality amongst the most interesting of fungi, and most instructive in regard of affinity, as well as in other important respects, he regarded them as scarcely worthy a botanist's notice; and, indeed, though at times impressed with more or less of philosophic doubt, he was inclined with Unger to regard them as mere abnormal developments of the cellular tissue of plants, analogous in plants to the exanthemata of animals.

Our business is not, however, with such productions at present, but with those compact fleshy or horny cellular bodies which occur so often in the guise of little flat cakes, irregular tuberiform masses, or seed-like organisms of a more or less definite form on decayed plants, whether more or less naked or buried in the midst of their pith, or other tissues, and more rarely on animal substances, which have been referred by authors to *Sclerotium*, and one or two allied genera. Fries still adheres to the notion that many of these are autonomous, and I have myself ventured to express an opinion that though the greater part are spurious, there may possibly be some which bear fruit, and are not mere conditions of other fungi, though the more the matter is considered the less reason there is to believe this possible.

In the *Systema Mycologicum*, while Fries confesses that they have affinities with every order of fungi, he states as his opinion

FIG. 2.—Thin slice from surface of *Sclerotium complanatum* highly magnified.

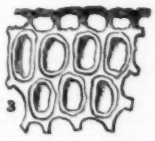


FIG. 3.—Thin vertical slice of *Sclerotium minutum* highly magnified.

that they are, according to the "notio idealis," *Coniomycetes* congested into a sort of hymenium. The notion was perhaps the most unfortunate that he could have formed, for with the exception of *Sclerotium betulinum*, and about three allied species, none of which are properly *Sclerotia*, they have no relation at all to *Coniomycetes*. In the year 1824 the cellular structure of the cuticle of *Sclerotium semen*, and more especially the waved

superficial cells in *S. complanatum*, so like those of the cuticle of many leaves, convinced me that there was much to make out about these plants, and soon after Dr. Greville's attention was called by me to the subject. A few years afterwards, on commencing an active correspondence with Fries, I pointed out to him the origin of *Sclerotium pyrinum* from the common *Penicillium*, and the necessity of modifying his notions as to their affinities. This *Sclerotium*, moreover, though evidently derived from the *Penicillium*, consisted, like other legitimate forms of the spurious genus, of a compact mass of cells, and not merely of close packed threads capable of being resolved by careful manipulation into the original flocci, which appears to have been the case with some supposed *Sclerotia* of similar origin, which were, in fact, nothing more than unusually compact examples of that state of *Penicillium* which has received the

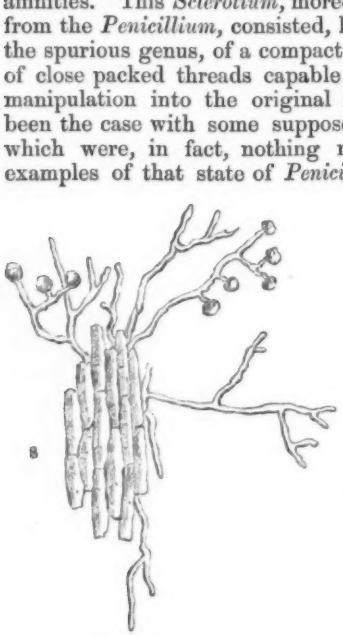


FIG. 8.—*Mucor Subtilissimus* springing from the tip of an Onion whose bulb was covered with *Sclerotium Cepæ*, highly magnified.

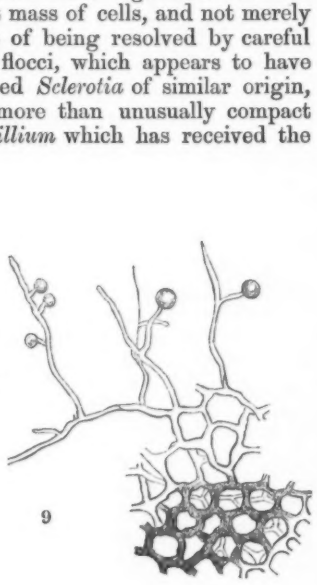


FIG. 9.—*Mucor Subtilissimus* springing from a thin slice of *Sclerotium Cepæ* placed in a drop of fluid in a closed cell, highly magnified.

name of *Coremium*. In 1848, in conjunction with Mr. Hoffmann of Margate, I succeeded in making a thin slice of the minute *Sclerotium* (*S. Cepæ, Libert*), which occurs sometimes in myriads, like the grains of coarse gunpowder, on onions, vegetate in a closed cell; and the result was the production of a minute species of mould which is figured in the *Journal of the Horticultural Society of London* for that year, under the name of *Mucor subtilissimus*. This was, of course, a step in the same direction as the tracing the origin of *Sclerotium pyri-*

num to the *Penicillium*. It had, however, been observed for some time that various hymenomycetous fungi were constantly connected with *Sclerotia*, and, in some cases, as in *Agaricus tuberosus*, *Typhula erythropus*, and *Peziza tuberosa*, the connection was so intimate, that it was matter of doubt whether the one was not a mere condition of the other. It has been left for modern observers to confirm this notion completely, and it is now well ascertained that plants of various affinities are capable of assuming a sclerotioid condition, in which they pass a greater or less time, according to circumstances, until a favourable opportunity arises for their complete development.

FIG. 5. *Typhula erythiopus*, nat. size.

Though many observations have already been made, much remains to be done, and we can scarcely conceive any more full of interest to the mycologist than those which may be made amongst these curious productions.

Sclerotia occur everywhere amongst decaying vegetable matter. The surface of the stems of our large herbaceous plants yield more than one; their pith, as for example, that of the sunflower or bulrush, yields others; several may be found on carrots and other roots, or tubers heaped up in cellars, and two at least on bulbs of onions in the garden. The tan of our stoves is frequently productive, the cow dung which has been exposed to the weather in our fields, decaying leaves, in woods and gardens, bletting or mouldy fruit, the roots of mosses, but more especially large decaying fungi like *Lactarius adustus*, which are driven about by the winds in our woods, afford a multiplicity of subjects for experiment. It may be remarked that many *Sphæriæ* in an early state of growth, as *Sphæria phæocomes*, for instance, appear under the form of *Sclerotia*. Indeed, many of the compound species either assume at times sclerotioid character, or the parts of the stroma which are ultimately destined to produce the asci, consist at first of a uniform cellular mass. This is especially observable in the genus *Dothidea* and *Hypocrea*, imperfect individuals of which might be referred without violence to the genus.

Nor must we pass unnoticed the productions of a similar nature which occur on anatomical preparations left for maceration or perserved in weak spirit. Even living bodies are not entirely without such organisms, or at least some which simulate them very closely. The fungus-foot of India, of which such an interesting account was published by Dr. Carter of Bombay, last year, is a case in point, though we are not certain whether the dark truffle-like bodies, some of them as large as

walnuts, which fill up as a bullet in its mould the more or less globose cavities which are hollowed out in the carious bones, consist of tissue so intimately compacted as to lose the character of threads entirely, and to justify their association with true *Sclerotia*. The specimens kindly forwarded by Dr. Carter in spirits, were perhaps more in favour of such an association than the drawings made from the specimens when fresh.

The greater part of these productions may be made to yield their proper fruit, either by covering them lightly with soil in a well-drained garden pot, and preserving them at once from too rapid evaporation, or from a degree of damp likely to generate mould by a bell glass either entirely closed, partially open above, or gently tilted. It will be necessary also to modify the light according to circumstances, the degree in which this may be needful, being entirely matter of experience. In other cases it will be better not to cover the *Sclerotia* with soil at all, but to place the leaves and sticks which bear them as nearly as possibly in their natural condition, while in others, the lower part of the mother-plant may be immersed in water in a wide mouthed bottle, the orifice being more or less completely closed, as may be judged best. Any one who has succeeded in raising the curious fungi of which ergoted grains are a condition, from the black spur-like bodies, will at once see what a fund of amusement is before the observer. Sometimes an Agaric or Coprinus will reward his care; sometimes a *Clavaria*, sometimes a *Peziza*, not unfrequently a *Pistillaria* or *Typhula*, while sometimes he must content himself, as in the case of *Sclerotium durum* and its varieties, or closely allied forms, with some humble mould. If he is in warmer countries than our own he may chance to have a good crop of edible fungi, though we must exclude the far-famed *Pietra Fungaja* which is so prized in Italy for the excellent fungi which spring from the tuberous masses of earth and spawn when moistened, because it is not really a *Sclerotium*. Ergot must also be excluded, as it has several material points of difference, though the cultivation for the production of its more perfect form is precisely similar to that mentioned above. If he has been diligent in collecting specimens from decayed

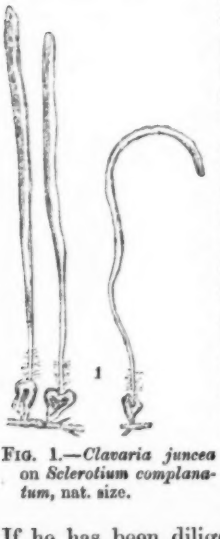


FIG. 1.—*Clavaria juncea* on *Sclerotium complanatum*, nat. size.

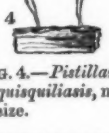


FIG. 4.—*Pistillaria quisquiliasis*, nat. size.

agarics, he may be fortunate enough to raise *Agaricus racemosus*, which is one of the most singular species of fungi ever recorded, presenting him with two distinct forms of fructification on the same root.

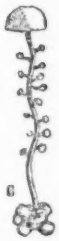


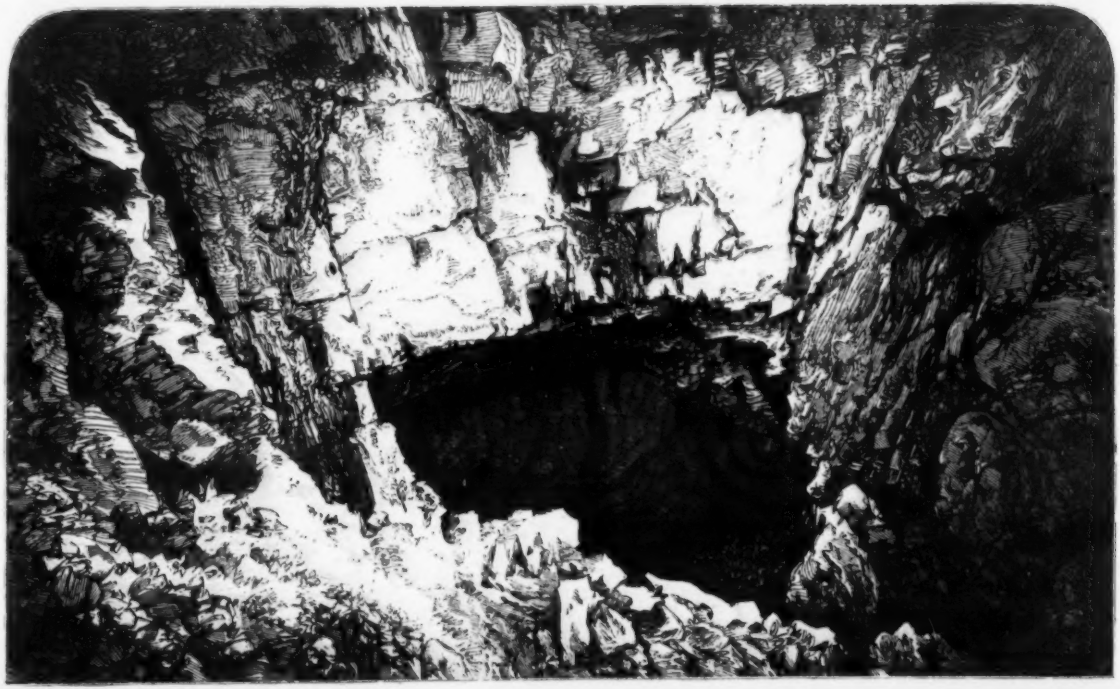
FIG. 6. *Agaricus racemosus.*

As an instance of the pleasure derived from this source, we may instance the success of Mr. Currey, who is doing so much for fungi, in raising a beautiful Peziza from the little pink-fleshed *Sclerotium Kneiffii* which occurs not unfrequently in the pith of *Scirpus palustris* and *Juncus conglomeratus* when fallen to the ground, and constantly saturated with moisture. But this is not the only pleasure which the mycologist may anticipate. He will soon perceive that the attentive cultivation of these *Sclerotia* will enable him to discriminate satisfactorily many closely-allied species. *Sclerotium complanatum*, and *S. scutellatum*, for example, both produce a *Pistillaria*, and the two at first sight may be considered as identical, but cultivation will doubtless give a nicer discrimination than we have at present respecting them. So again there is a *Peziza* which springs from a white-fleshed *Sclerotium*, very like *Peziza Curreyi*, which, as said above, is due to a pink-fleshed kind, and other instances might be adduced. Much information will be found on the subject in Tulasne's new work, *Fungorum Carpologia*, which contains a mass of information unequalled in any work with which I am acquainted. One of the most curious instances that he adduces of a fungus appearing in a dormant state under a sclerotioid form, is that of the cobweb-like *Corticium arachnoideum*, which is common in almost every wood on fallen sticks, forming a very thin white film, spreading over, but not adhering, like so many of its relations, to the matrix, the very last fungus perhaps one would suppose likely to assume such a form. From the sterile threads there arises sometimes in great numbres, sometimes more sparingly, little velvety white heads, which gradually become smooth, acquiring a light red or bay tinge, and, in fact, are so many globose or irregular *Sclerotia* of various dimensions, from that of a poppy-seed to that of a hemp seed, or even more. These are at length of a deep chesnut or somewhat variegated, and consist of an extremely solid mass of cells. They remain either attached to the matrix or fall to the ground, and when the proper season comes round, reproduce the web-like fungus. Tulasne remarks further that it will be matter of wonder to many that a delicate byssoid fungus, such as *Corticium arach-*

FIG. 7. *Peziza Curreyi* on *Sclerotium Kneiffii*, nat. size.

noideum, should be capable of cultivation. A quantity of these *Sclerotia* on dry bark were collected by himself, in conjunction with his brother, in winter, and in the following April were placed in sand. They remained dormant till the end of summer, when the surface of the sand began to be covered with a very delicate web, which in the middle of September had spread in every direction and continued to do so for months, though individual *Sclerotia* dug up in the month of October, seemed quite unaltered in size, colour, or density. He remarks, moreover, that the formation of a previous mycelium from the *Sclerotium* is without example so far as his observations go, the fungus arising in other cases immediately from the *Sclerotium;* though Léveillé makes a different statement in his paper on *Sclerotia* in the 20th volume of the second series of *Annales des Sciences Naturelles*, which will be found well worth attention.

A taste for the cultivation of cryptogamic plants in general is gaining ground in this country very fast. Not only are ferns favourite objects of cultivation, but houses are now devoted to mosses and liverworts, many of which grow admirably when guarded against the attacks of the white mycelium of a little scarlet *Nectria*, which if not constantly rubbed off, soon makes dreadful havoc amongst them. That fungi admit of extensive cultivation cannot be doubted, when the luxuriance of such agarics as *A. Cepæstipes*, *A. clypeolarius*, and *A. volvaceus*, and, I may add, their beauty in our stoves is taken into consideration. The Australian *Aserŏe rubra*, one of the most interesting and beautiful, though not the most sweet scented of fungi, once made its appearance at Kew, as did the lovely *Marasmius hæmatocephalus*, with its blood-red pileus, slender fawn-coloured stem, and cream-coloured hymenium. Many species could undoubtedly be imported, and especially those which in a dormant state assume the condition of *Sclerotia*. Our native *Sclerotia* will not indeed produce many species of brilliant colour, but their progeny often exhibit an elegance of form and delicacy of tint which command admiration from every lover of the intrinsically beautiful. We trust, then, that the time may not be far distant when there may be, besides the ordinary mushroom bed, a fungus-house as well as a fern and moss-house in every first-rate establishment.



Roman Mine.

ROMAN MINING OPERATIONS ON THE BORDERS OF WALES.*

BY THOMAS WRIGHT, M.A., F.S.A.

Our history of the first establishment of the Romans in Britain is very imperfect and very obscure. After a short campaign under Claudius, A.D. 43 and 44, which appears to have been carried on chiefly in the south, we find the Romans exercising a superiority over all the eastern and central States, including that of the Brigantes, and suddenly carrying nearly all their forces to the borders of Wales. When Ostorius Scapula was sent, in the year 50, to take the command of this distant province, and to suppress the disorders which had arisen in it, he made the Avon the base of his operations, and then marched into the country of the Cangi, who evidently inhabited the districts lying on the northern coast of Wales. Beyond their territory, the Romans came upon the sea that looked towards the island of Ireland. They were called back from this conquest, first by a revolt of the Brigantes, and then by the more resolute hostility of the Silures of South Wales, which led to the defeat and capture of Caractacus. Under the government of Suetonius Paulinus, in the year 61, the spirit of insurrection was again active in Britain, and the Romans appear attaching the same importance to that district of the Cangi; for his grand exploit was the reduction of the Island of Anglesey, because it was by the Britons assembled there that the Cangi were continually urged into revolt. The multitude of the Roman troops was still collected in this quarter, and it was from thence that they were taken to repress the more formidable insurrection of Boadicea.

We might naturally inquire what was the particular circumstance which drew the attention of the Romans, at this early period, so strongly to this distant part of Britain; and a rather curious antiquarian discovery furnishes the reply. In 1783, a Roman pig of lead was found in Hampshire, bearing the inscription:—

NERONIS . AVG . EX . KIAN . IIII . COS . BRIT

intimating that this lead was taken from the mines in the country of the Kiangi, or Cangi, in the fourth consulate of the Emperor Nero. Now Nero's fourth consulate began in the year

* Since this article was written, we learn that Mr. More, of Linley Hall, has contributed to the International Exhibition a very elaborate model, on a large scale, with plans and sections, of the Shelve mining district, in which all the remains of the Roman mines are shown, and that he will exhibit in the same case the various objects which were found in or in connection with the latter.

60, so that this pig was probably cast in the year before Boadicea's revolt. It is clear, therefore, that it was the metallic riches of the mountains on the border, and on the northern coast of Wales, which drew the Romans thither at so early a period. Britain had long had a celebrity for its richness in metals, derived from the treasures carried from the south, and the Romans would no doubt be attracted by any report of mountainous districts. They had thus at a very early period fixed upon the peak of Derbyshire; and in the mountains of the Welsh border, their richness in metals must have been visible on the surface, and would have caught the eye of the Roman metallurgists at the first glance.

There are evidences of a much more definite character, which show the extent to which the Romans laboured on these metalliferous regions, and which will repay well the labours of the scientific inquirer in exploring them. The attractions of these researches is increased by the fact that the most imposing remains of the Roman mining operations are scattered through by far the most lovely scenery of the Welsh border. We may trace them from the wild country of the Forest of Dean, and the beautiful Wye scenery in the south, through the hills of Shropshire and Montgomeryshire, Cheshire, and the countries of Flint and Denbigh, and through the ancient country of the Cangi, or Kiangi, up to the shores of the Irish Channel. We can only, in the space here allowed us, review this extent of country briefly, but we will begin with the iron district in the south.

The best position from which to visit the Roman mining districts of the Forest of Dean is Ross or Monmouth. Nearly the whole country for some extent on both sides of the river Wye, between those towns, has a deep substratum of the scoriæ from the Roman iron works, sometimes lying close upon the surface. I am told that in places the depth of scoriæ has been found to be from twelve to twenty feet, and I have myself traced it on the surface over a considerable part of the district. Coins and pottery of the Romans, and other objects, found frequently among the scoriæ, leave no room for doubt that the latter were deposited there by that people.

Nor are their cinders the only remains of their iron works, which that extraordinary people have left behind them in this district. In the turn of the river Wye, amid the beautiful scenery between the ruins of Goodrich Castle and Monmouth, rise two massive hills, called the Great and Little Dowards. They consist of mountain limestone, resting on the old red sandstone, in the former of which the iron ore is here found. Both hills have been largely mined by the Romans, and their manner of proceeding on this occasion is explained fully by the entrance

to one of their mines, which still remains on the site of the Great Doward. They had excavated a large cavern into the side of the hill, and wherever they came upon the vein of iron ore, they followed it into the heart of the mountain. Thus from the cavern, as it still exists, rude galleries run in more than one direction, leading to successions of chambers made by the extraction of the iron ore. The entrances from the outer cave are now much clogged up, but they are said to have been entered and explored to a great depth underground. They are, as is frequently the case with such remains, the subject of many popular legends of fairies which dwell in them, hidden treasures, and the like, and the entrance cavern is called in the locality "King Arthur's Hall." On the adjacent Little Doward there is an ancient entrenched inclosure, which had probably some connection with the mines.

The Romans had, in this district, another method of mining, or rather a modification of the same, which was caused by the character of the ground. It is seen to most advantage in the neighbourhood of Coleford, on the Monmouth side of the Forest of Dean. Coleford is reached most easily from Monmouth, through a country of mountain and forest of the greatest beauty. It is situated upon the same mountain limestone which here skirts the Forest of Dean, and in which the iron ore is found; but here, as the ground lies more level, and cannot be entered from the side of a hill, the Romans began their operations by sinking a large pit—in some cases these pits are from twenty to thirty feet in diameter—and when at the bottom of this pit they came upon a vein of ore, they followed it just as they did the veins from the cave in the Great Doward. These pits as they now remain are popularly called *scowles*, a word the origin or meaning of which I have not been able to discover. They have, as may be supposed, rendered the ground on which they are situated very uneven, and unfit for cultivation; it is thus always overgrown with copse and brushwood, and it requires some care on the part of the explorer not to fall unawares into a pit. They are seen to most advantage not far from a farm house, called, from them, the Scowles Farm, about a mile to the westward of Coleford. In one of these scowles which I examined, the round pit, was nearly twenty feet deep, at which depth the Romans had come upon a vein of ore, which they had followed by a shaft, the entrance to which looks now something like the mouth of a large oven. Without a light, and the other necessary accoutrements of a miner, it was not advisable to enter beyond a few feet; but a stone thrown in could be heard rolling down for some seconds; and the cottagers stated that some of these mines extended two or three hundred feet

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underground, and that they could easily descend them with lanterns, and generally found clear water at the bottom. The ore is of fibrous appearance, and so rich in metal that it often looks like malleable iron, and pieces of it are picked up plentifully about the Roman mines. That they are Roman we can have little doubt, from the frequent discoveries of Roman coins and pottery in and about the scowles.

Space will not allow of any detailed description of the scoriæ which are found in such marvellous quantities over this district, but which, nevertheless, present many circumstances worthy of remark. There can be no doubt that wood was used in the smelting, as pieces of charcoal are often found imbedded in the cinders. The Roman process of smelting was evidently very imperfect, for they still contain so much ore, that in the seventeenth and eighteenth centuries they were carried away and re-smelted on an extensive scale, and large quantities of iron were thus obtained.*

This incredible quantity of the scoriæ shows the immense activity of the iron mines in this district during, no doubt, the whole Roman period. They are traced also, I believe, in some parts of Monmouthshire, but its neighbour, Radnorshire, is not a mining district, and we find no further traces of the eagerness of the Romans to profit by the existence of metallic treasures till we reach the lead and copper fields of Salop and Montgomery.

The most important group of the Shropshire lead-producing mountains is that of the Stiperstones and its dependents, especially that which is known as Shelve Hill. My head-quarters for exploring this district have always been at the hospitable mansion of an esteemed friend, the Rev. T. F. More of Linley Hall, one of the most lovely spots in this island. Mr. More takes in his mining property all the interest of an antiquary and of a man of science. The park of Linley runs from the hall, first northward, and then bending round to the west, along a narrow and beautifully picturesque valley, between ranges of mountains, a distance of about three miles, at the end of which we enter the high road from Newtown and Bishop's Castle to Minsterley. Two miles along this road, towards the latter place, brings us to a long mountain, extending nearly north and south, and parallel to the Stiperstones, at a distance of some two miles to the west, which is called, from the name of the parish in which it is situated, Shelve Hill. This hill, the property of Mr. More, is full of lead ore, which runs in almost horizontal veins from east to west, turning a little towards the north-west, and when

* A more full account of the Roman iron works in the Forest of Dean, and also of those of the weald of Kent and Sussex, will be found in a little volume by the author of the present paper, entitled *Wanderings of an Antiquary*, published in 1854.

the Romans came to these parts, all these veins cropped out on the surface on the western side of the hill. The Romans, who considered lead as a very valuable metal, were not likely to overlook so open a manifestation of great wealth, for the ore in this locality is particularly rich, and this locality was without doubt the scene of some of their earliest mining operations. Lead is the only metal produced from the British mines of which we find the pigs bearing the imperial marks, and these pigs have been found in rather considerable numbers. All such pigs of the Roman period hitherto found under circumstances which would lead us to suppose that they came from the Shelve Hill mines bear the same mark, that of the Emperor Hadrian (A.D. 117—138), in the simple form—

IMP . HADRIANI . AVG

from which it would appear that the mines were in great activity in the earlier part of the second century. Three of the pigs of lead with this inscription are well preserved; one found on Mr. More's own property is to be seen among the curiosities at Linley Hall; another, found in the parish of Snead, near Linley, is now in Mr. Joseph Mayer's museum, at Liverpool; and a third, found in the last century at Snailbeach, is deposited in the British Museum. With these facts before us, it is more than probable that it was to this locality that Pliny referred, when, writing before A.D. 79 (when he died), he says, that lead (which he calls *nigrum plumbum*, to distinguish it from *plumbum album*, or tin), was found in Britain so plentifully on the surface of the ground, that it was thought necessary to pass a law to limit its extraction.*

The remains of the Roman workings on this spot are of a very remarkable character. Pliny's description of the lead as found *summo terræ corio*, on the very skin of the earth, was here literally true, for some eight or nine parallel veins came out upon the surface of the rock, and all these the Romans worked, beginning apparently from the bottom of the hill, and following the vein into the rock, as far as they could trace it. The remains of their labours are visible along the whole surface of the hill, like irregular cuttings along a large cheese; but it presents the most remarkable appearance at a spot near the northern end, where, at the foot of the hill, a mine called the Roman Gravel Mine is now in operation. The way in which the Roman miners followed the veins of ore is here exhibited in the most remarkable manner. Where it did not appear to run deep they soon stopped, and have left but a

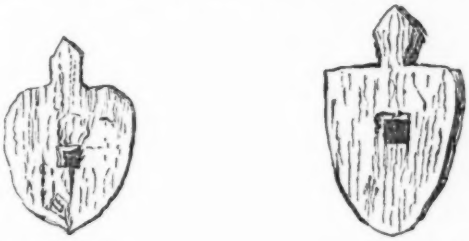
* Nigro plumbo ad fistulas laminasque utimus, laboriosius in Hispania eruto totasque per Gallias, sed in Britanni summo terræ corio adeo large, ut lex dicatur ne plus certo modo fiat. Plin. *Nat. Hist.* lib. xxxiv. cap. 17.

shallow cutting. In some places the cutting is wide; while in others it is at the same time very narrow and very deep, in one instance sinking to a depth of, I believe, forty yards, yet not wide enough for more than one man to work in it. In other places the vein of ore had been more massive, and in following it the Romans had hollowed in the rock cavern-like chambers, from which galleries ran in different directions, which are now blocked up by rubbish. The entrance to one of these caverns is shown in the accompanying engraving, made from a very excellent photograph by Mr. Colley of Shrewsbury. The Roman miners also sunk shafts. In one of the largest of the caverns on the line of the vein I am describing, near the brow of the hill, the vein has been followed downward by a shaft of great depth; in its present state a stone is heard rolling down for several seconds. It is not easily examined from its position, but having been carried up to the surface of the rock above, no doubt for the purpose of more easily raising weights up and letting them down, we were enabled to ascertain that it was a square shaft of small dimensions. We have, however, still better evidence of the extent to which the Roman miners perforated the mountain. I have just stated that at the bottom of the hill, just under these large Roman surface workings, there is a modern mine, which was begun some years ago, but, for some reason or other, was soon abandoned. This mine has been recently taken by a most respectable company, which has taken the name of the Roman Gravel Lead Mining Company, who in the prosecution of their own works have met with numerous Roman shafts and galleries to a considerable depth.* The antiquity of these mines has been proved, not only by the Roman pigs of lead already mentioned, but by Roman coins and pottery found from time to time among the old rubbish. Early mining implements also have been found, but none have been preserved, with the exception of a curious description of spade, two examples of which, in the possession of Mr. More, are represented in the accompanying cut. These spades are formed of laminæ of oak timber, roughly split, and cut into the shape here exhibited, with a very short stumpy handle, and a square hole, sloping on one side in the blade. This hole was evidently intended to receive a short staff, which might be used as a lever

* When we consider the facility which nature gave to the ancients to obtain the higher metal from the surface, and the length of time they no doubt worked the mines, and the fact that we learn from ancient documents that mines were worked here in the middle ages, and at various more recent times, and that during the last seventy years an unceasing large supply has been raised, although not a fifth of the ground has been explored, we may imagine the richness of this district in ore. Immediately under one part of the ancient workings, about fifteen years ago, one pipe of ore produced two thousand tons in eleven months at a depth of eighty yards.

to give force to the movement of the hand; and the implement itself was no doubt designed for shovelling the broken stones containing the lead ore in narrow passages where there was not space for giving much movement to the body. The dimensions of the two spades here represented are nearly 8½ inches by 16, and 8½ by 11. It is worthy of remark that similar spades have been frequently found in other parts of our island in the remains of mines which no one doubts to be Roman; and these confirm us in believing them to be of the Roman period. They furnish a remarkable proof of the great durability of sound oak.

No traces of the washing and smelting places attached to these Roman mines have yet been met with; but they are accompanied



11 inches by 8½. 16 inches by 8½.

OAK SPADES FOUND IN ROMAN MINES.

by other monuments of a very important description. The remains of a very extensive Roman villa have been discovered, occupying the southern part of the park at Linley and part of the adjacent fields, and standing in a very commanding position. This great mansion, which covered the space of a small town, had no doubt some connection with the mining works in the mountains above. Again, to the north of Shelve, at the extremity of the Stiperstones, and in the parish of Minsterley, is the Snailbeach mine, one of the most productive lead-mines in this kingdom. It also had been extensively worked by the Romans; and the miners, I believe, still speak of the upper part of it as the Roman level. Two or three miles distant, in the fertile country below, the remains of a fine Roman villa have also been found in the parish of Pontesbury.

Westward of the Stiperstones mountains, and through the county of Montgomery, copper and lead are found in abundance, and we trace everywhere the presence of the Roman miners. Roman mines have been found in Newtown Park, and were re-opened a few years ago. They were found productive in copper and "silver lead;" to explain which, it may be stated

that the lead ore found in this country has always an alloy of silver, varying in quantity, and particularly rich in the latter metal as we go westward into Montgomeryshire. At present the alloy of silver is considered rather as a defect than otherwise, as it is not worth the trouble of extracting; but the Romans, who set greater value on silver, extracted it with care, of which many of the Roman pigs of lead found in England bear testimony by the words in the inscription—EX. ARG., or LVT. EX.ARG., or MET.LVT.EX.ARG., the latter of which has been interpreted as meaning *metallum lutum ex argento*, metal washed from silver, in accordance with Pliny's account of the process of extracting the more precious metal from the other; but LVT. has also been interpreted, perhaps rightly, as referring to a mining town or district in Derbyshire, named by the Romans Lutudæ. I believe that among the miners on the borders of Wales, the lead ore is still sometimes called silver. Most of the Roman mines in Montgomeryshire, as far as they have yet been observed, are formed by shafts sunk from the surface, or from caves made in the bank. In the park at Newtown, they thus sunk shafts for copper, and appear to have been very successful, to judge by the report of the resumption of these excavations in 1856.* About six miles westward from Newtown, on an elevation on the banks of the Severn, are the remains of a rather important Roman station, called by the Welsh Caer Sws, probably a mining town, in the neighbourhood of which I believe that remains of Roman mines are also found, and by which runs a Roman road, called in Welsh Sarn Swsan, which is said to run by way of Rhaiadyr through this mining district towards Chester. At the western extremity of the county of Montgomery, in the park of Machynlleth, a Roman mine was also re-opened in 1856, which produced copper and "silver-lead." Like most of these ancient excavations, it had become an object of superstition,

* An account of the re-opening of this mine was communicated to Eddowes's *Shrewsbury Journal*, in October, 1856, by a mining captain at Llanidloes, Mr. William Vivian, who says—"The interest excited in Newtown by the opening of the old mine at the Park, near that place, has caused me to direct my attention to that interesting spot. I have this day inspected the ancient works, and find that, in clearing out the level, an old shaft has been discovered, sunk, it is supposed, upwards of a thousand years ago. The men are now employed night and day in clearing the shaft, and they have already arrived to the depth of ten fathoms, but have not as yet reached the bottom. Amongst the stuff now being brought up are some ancient pieces of oak timber, and, strange to say, also large quantities of bones, supposed to be those of the deer, which, owing to their having been lodged in mineral water, are in perfect preservation and freshness. The lode at this part of the shaft is about four feet wide, composed of barytes, intermixed nicely throughout with copper ore, just diverging into silver lead; at which point the lode and branches (which are about ten feet wide) fall altogether into the main vein, showing perhaps one of the finest lodes at the same depth in this or any other country; indeed, had such a lode been discovered in the mining districts of Cornwall or Devon, it would have been considered of immense importance."

was believed to be the dwelling of the fairies, and had obtained the popular name of the Ogo-Gwyddsyg, or Witch's Cave.* Machynlleth itself has been supposed by antiquaries to stand on the site of a Roman town, but about two miles from it, at a place called Cefn Caer, on the ridge of the city, are the undoubted remains of an extensive Roman settlement. In the neighbourhood of Llanrhaiadyr, on the borders of Montgomeryshire and Denbighshire, the Romans appear also to have had extensive mines, and at no great distance from this place probably stood the Roman station of Mediolanum, on the great Roman road from Uriconium (*Wroxeter*), which passed hence over the mountains of North Wales to Segontium, near the modern town of Caernarvon.

To the east of the Stiperstones copper is found, but not in such quantity as to pay for the labour of mining, as far as it has yet been discovered. I am informed by Mr. More that the little stream, which enters his park under Radley Hill, which is marked in the Ordnance Survey map as the Black Brook, and which runs southwardly at the eastern foot of the Stiperstones, divides the lead district from the copper. The hill in Linley Park, opposite Radley Hill, certainly contains copper; and there are traces of copper over the whole district between Minsterley and the Stiperstones on one side, and the Long-Mynd on the other. Copper has also been found, though in no great quantity, in Lythe Hill, facing the entrance to the Church Stretton Valley. Hence the copper district turns northwardly. To the north of Shrewsbury we meet a flat country with a broken line of eminence, represented by Grinshill and the Hawkstone hills, which all contain copper. My friend Mr. Samuel Wood informs me that there are traces of mines which had been worked

* The following paragraph appeared in the *Shrewsbury Journal*, May 14, 1856:—"Ogogwyddsyg, or the Witch's Cave.—In the park near to the town of Machynlleth is a deep pit, known by the above name, attached to which are many legends of ghosts, hobgoblins, and fairies; and occasionally pranks have been played off on old crones and timid maidens as they passed at night, so that the road has been shunned as haunted. The scene has, however, changed in one short week; and however it might be shunned after nightfall, it is the great attraction of the neighbourhood by day. An active miner, Morris Williams, conceiving this to be an old Roman mine, applied for a take-note to Sir Watkin W. Wynn, which being promised, he commenced, with the aid of Mr. Weston, a gentleman residing in the town. As the water was reduced they came to some woodwork, and an old shaft was soon developed, which was dried, and at the bottom was discovered a second shaft about eighteen feet deep, also timbered; but owing to the obstructions and danger attending the getting the water out of it, it was resolved to drive a level upon it. This is now in progress upon the course of a fine lode, from which there have already been taken some fine stones, rich in silver and copper. At the foot of the work flows the little stream called Nant-yr-Arian, or the Silver River, a name, doubtless, arising from the knowledge, in days of old, of the precious metal through which it flowed, though, till now, its origin has been long unknown. The quiet town of Machynlleth has been roused into a state of unusual excitement by this unexpected discovery."

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by the Romans at the Clive near Grinshill, and he is of opinion that the well-known grotto in Hawkstone Park, with its dark passage of eighty yards, was certainly formed by the Romans in working for copper ore. From this spot the traces of Roman mining disappear until we arrive at the hill of Llanymynech, on the northern borders of Shropshire and Montgomeryshire, in an isolated part of Denbighshire, a few miles from Llanrahaiadyr, already mentioned. Llanymynech Hill is a mountain of limestone of considerable extent, arising from the plain at some distance in advance of the edge of the mountain district of Denbighshire. Between the strata of lime occurs a very tenacious smooth clay, with orange-coloured ochre and green plumose carbonate of copper. It was the latter which attracted the Roman miners; and the remains of their extensive works are found on the north-west side of the hill, consisting of shallow pits, the debris from the excavations of which are full of small pieces of copper ore. In the neighbourhood of these pits are found traces of vitrification which show that here the Romans smelted the copper on open hearths. Their excavations, however, were by no means confined to the surface, for there still remains a very large cavern, known popularly by the Welsh name of Ogo (the cave), from which run irregular winding passages, connected with which are the remains of air-shafts. The Ogo at Llanymynech, like so many of these monuments of primeval times, is popularly believed to be inhabited by fairies and similar beings; a lad, whom I once took for my guide thither, knew all about these spirits of the mine, and gave me an account of one of the miners, with whom he was acquainted, who, coming over the mountains rather late at night, had seen the fairies dancing on the sward. But, though not very easy of access at the commencement, the Roman workings in the interior of Llanymynech Hill have been explored more than once, and are better known than those in any other locality. In the latter half of the last century they were entered more than once by miners in search of copper, who found a number of Roman coins, some mining implements, and, it is stated, culinary utensils, and several human skeletons and scattered bones—one of the skeletons having a bracelet on the left arm, and a "battle-axe" by his side.* Some of the mining implements were deposited with other antiquities in the library of Shrewsbury School, but they have long disappeared. I possess a drawing of one, which was a roughly made iron implement resembling a pick, except that it had only one limb, and which had evidently been used for pulling out the rock after it had been cracked and broken. At a later period, a man well known

* See *Pennant's Tours in Wales*, edit. of 1810, vol. iii. p. 218, and *Nicholson's Cambrian Traveller's Guide*, under *Llan y Mynach*.

in the literary history of Shropshire, J. F. M. Dovaston, explored the Roman workings as completely as it could be done, taking the precaution of carrying a piece of chalk with him to mark his way. Some of the shafts, or passages, which were extremely sinuous, extended as far as two hundred yards, sometimes they were so small that it was necessary even to creep through them, but they were usually from a yard to three yards wide, and from time to time became developed into broad and lofty chambers, where the ore had been found in larger quantities. They had all been cut through the solid rock, and in many places the marks of the chisel were distinctly visible. "Long passages," we are told in the account of this exploration, "frequently terminate in small holes about the size to admit a man's arm, as if the metal ran in strings, and had been picked out quite clean, with hammers and long chisels, as far as they could reach." It may be added that the roofs of these caverns were covered with pendent stalactites, which glittered brilliantly in the light of the torches. So many human bones were found scattered about, that it was conjectured that these caves had become a place of refuge in the troubled times which followed the overthrow of the Roman power, and that the fugitives had perished there. Roman antiquities of various kinds, and especially coins, are often found on Llanymynech Hill; of the latter, a friend in Shrewsbury, Mr. Henry Pidgeon, well known for his zealous and successful investigations of Shropshire antiquities, possesses about twenty copper coins found here, ranging from the earlier emperors to a tolerably late period of the imperial sway in Britain. The metal which was taken from the mines I have been describing was no doubt copper; but the Romans obtained also from this hill lead and calamine. Llanymynech Hill still produces both copper and lead, though, I believe, not in very large quantity.

The Romans seem not to have been aware of the existence of iron in Shropshire; but there can now be no doubt that they discovered the Shropshire coal-field. It has been long suspected that they used mineral coals in Britain, though different circumstances rendered it very difficult to substantiate the conjecture; but the question has been set at rest by the recent excavations at Wroxeter, on the site of Uriconium, where mineral coal is found in abundance, both unburnt and in cinders, and under circumstances which can admit of no doubt. It appears to be, generally, a coal of inferior quality which they found near the surface, and which is still spoken of as surface coal.

When the Romans came into Britain, the metals in these parts of the island were probably as yet undisturbed, and they found employment enough where the existence of ore

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was plainly indicated on the surface of the earth. From the copper and lead of Shropshire we find few, if any, traces of their labours until we reach the mountains of Flintshire, where copper and lead again presented themselves on or near the surface. We are now, no doubt, in the country of the Cangi, which, stretching along the coast districts to Bangor, is full of mineral wealth; but I must pass over it briefly. The remains of Roman lead-mines are met with in almost every part of this district, and they usually present features similar to those observed at Shelve, in Shropshire. It is a remarkable circumstance that, in the latter locality, and similarly in the mining districts of Montgomeryshire and at Llanymynech, we are so entirely ignorant of any deposits of scoriæ, or slag, that we might suppose that the ore had been carried away to be smelted elsewhere, were not this hypothesis contradicted by the discovery in the immediate neighbourhood of the pigs of lead ready for exportation. This is not the case in Flintshire, where the land bordering on the coast to the west of Flint is covered with thick layers of lead scoriæ, deposited in the same manner as the iron scoriæ on the borders of the Forest of Dean. These scoriæ are found chiefly at Croes-Ati, a kind of eastern suburb of the town of Flint, and in the adjoining parish of Northop; and, like the iron scoriæ of the south, the process of smelting had been performed so imperfectly, that in the time of Pennant, who is our chief authority on the traces of old mining operations in this part, people collected them and subjected them again to the process of smelting, and thus obtained large quantities of metal.* Pennant further informs us that rudely-made pick-axes had been found in the Roman mines in Flintshire; and that distinct marks of fire were found in the deep parts, as though the rock had been heated and cold water thrown on it while hot to make it crack†—a process which is alluded to by Pliny. Pennant had an iron wedge, thickly incrusted with lead, which had been found in the ancient workings in the parish of Dyscarth.

From the quantity of scoriæ found at Croes-Ati and Northop we are justified in supposing that the lead-ore was brought down from the Flintshire mountains to be smelted at this spot; and the activity of the miners of this district is proved by the great numbers of Roman pigs of lead, all belonging to early emperors, and bearing the mark DE.CEANG, which have been found in the adjacent county of Chester. One of these was found in 1838, at about a mile from Chester, in excavating for the railway to Crewe, and bore the date of the third consulate of Vespasian, A.D. 74. In the time of Camden no less than

* *Pennant's Tours in Wales*, vol. i. p. 71. † *Ibid.* vol. i. p. 74. See also, vol. iii. p. 58.

twenty pigs of lead were found together at Runcorn, on the Cheshire coast, near the mouth of the Mersey, all bearing the inscription DE.CEANG; some of them bearing date in the fifth consulate of Vespasian, A.D. 76, and others inscribed with the name of Domitian, A.D. 81-96. Another, with the mark of the Ceangi, or Cangi, and the date of the fifth consulate of Vespasian, was found in 1772 on Hirst's Common in Staffordshire, near to Watling Street, where it had been left in its transit from the mining district to the south. It is a remarkable circumstance that nearly all the pigs of lead found in Britain bearing the imperial mark, belong to the early emperors, and the absence of any of a later date perhaps implies some great change in the system of administration of the mines.*

The Romans found lead again in the limestone mountains behind Abergele. On the side of one of these, which, from some ancient intrenchments on its summit, is called Castell Cawr, the vein of lead appears to have cropped out on its surface as in Shelve Hill; and in following it the Romans have cut a trench across the mountain of such vast depth and width, that the cuttings on Shelve Hill are mere scratches in comparison to it. After the departure of the Romans, this country had been left so wild and unfrequented that the caverns of the Roman miners became the haunts of beasts of prey; and the trench of which we are speaking received from the Welsh the name of Ffos y Blaiddiaid, or the Wolves' Ditch. More recent attempts at mining have showed that the Romans had penetrated deep into the hill, and had cleared away the ore. They are thus recorded in the local guide-books: "In driving a level into the mountain some years ago, the miners discovered that the Romans had been deep in the bowels of the earth before them. They had followed the vein where it was large enough to admit a small man, and where it opened out into a larger chamber, they had cleared it quite away. When the vein became too small to admit a man, they were obliged to relinquish the ore. Some curious hammers and tools, but almost decayed into dust, were found in these chambers."

We are now leaving the borders of Wales, whatever limits might be given to them, but we may still pursue the Roman mining operations through the country of the Cangi. They found copper in the Great Orme's Head, and worked it successfully; and when digging for the foundations of buildings in the town of Llandudno the modern excavators came upon the soil

* A complete and valuable list of the Roman pigs of lead found in this country, was contributed by Mr. Albert Way to the *Archæological Journal*, and another will be found in a paper by Mr. James Yates, "On the Mining Operations of the Romans in Britain," published in the *Proceedings of the Somersetshire Archæological and Natural History Society.*

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of the Roman level, coloured by the washings of the ore. I believe that in the neighbourhood of Caerhen or Caerhun, supposed to represent the ancient Conovium, about five miles to the south of Conway, there are also traces of ancient mining. Here was found, in the last century, a mass of copper in form like a cake, but weighing forty-two pounds, which had evidently come fresh from the smelting. It bore two singular inscriptions, which have not been satisfactorily explained; one was SOCIO ROMAE, the other NAT SOL, supposed to be for *natale solum*. It is, I believe, still preserved at Mostyn. The Romans found copper in the mountains of Anglesey, and although they failed to discover the immense mass of that metal which has given celebrity to the Parys mountain, the remains of their mining operations are found in its immediate neighbourhood.

A comparison of these various remains give us a tolerably complete view of the manner in which the Romans obtained metals from the earth. It is more than probable that, in these districts at least, no miners had preceded the Romans, who therefore found the veins of metallic ore on the surface, and first worked upon them there, until, when they were obliged to trace them further, they followed them by shafts and galleries. They evidently preferred, where it was possible, to make a cave on the side of a mountain, or sink a pit in the ground till they came to a vein, and then follow and clear away the vein itself. They worked with rude implements, including wooden shovels and wedges, and chisels of stone. It was the work of slaves and condemned criminals, and was no doubt laborious and slow, but at the same time productive, because they found the metallic ores where they were abundant and often easy of access. The ore itself they seem to have worked out with chisels and axes, and when they had to deal with the hard rock, they cracked it by the application of fire, and then split it further with wedges of iron or stone, and pulled it apart with rough iron picks. In smelting, they evidently used nothing but wood; coals seem not then to have been found in sufficient abundance, and the smelting was performed on the spot and very imperfectly.

This inquiry also leads to very important results, throwing light on the condition of Roman Britain, and these results will be more important as we trace the Roman mining operations through the interior of Wales. We shall find the whole of that country, even into the districts which have hardly been approachable since the Roman period, in the peaceful occupation of the imperial colonists, and covered, even in the wildest mountain districts, with excellent and numerous roads, and with towns, stations, country villas, and settlements of all descriptions, quite contrary to the old popular notion, that here the Britons

continued to retain their independence; and at the same time we understand why, at so early a period of their conquest, the Romans established permanently at the southern and northern extremities of the border of this mountain district two of the three legions which occupied the island. It was not to hold in check independent and turbulent natives, but to overawe a large population of slaves and condemned criminals who were employed in the extensive mining operations. Many of the numerous early entrenched inclosures which are scattered over the mountains in which the mines were situated, and which our antiquaries have so hastily and so injudiciously called camps, contained probably villages of miners, or places for works in connection with the mines, or possibly posts which were occupied from time to time by detachments of troops when their presence happened to be necessary.

METEOROLOGICAL OBSERVATIONS AT THE KEW OBSERVATORY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BY CHARLES CHAMBERS.

INTRODUCTION.

The situation of the Kew Observatory, in the north-western part of the Old Deer Park, is on the whole well adapted to afford true indications of meteorological phenomena. The building, which was erected about eighty-five years ago as a private astronomical observatory for George III., stands on a slight elevation surrounded by a flat grassy surface, and is freely exposed to winds from every direction, the nearest obstacles being three elm-trees 170 feet to the south-east. The Thames sweeps close past the boundary of the park, approaching very near to the observatory, which it surrounds on all sides but the east; a circumstance which may render the moisture of the air somewhat higher at Kew than at other places in the same locality, its effect being evident in an extreme prevalence of fogs.

BRIEF DESCRIPTION OF THE INSTRUMENTS.

Barometer.—This instrument, which is one of Newman's construction, is placed in the east room, on the first floor of the building, with its cistern at a height of about thirty-four feet above the level of the sea. The internal diameter of the tube measures 0·55 inch. The temperature of the mercury and of the scale is observed by a thermometer immersed in mercury contained in a tube of the same bore as the barometer, and

placed alongside of it. Newman's standard has been found to accord with the two large standard barometers of the observatory which also agree together.

Thermometers.—These are supported in a wooden frame, or cage, opposite the north entrance of the observatory, at a height of eleven feet above the ground. The sides of the cage are like venetian shutters, consisting of flat bars of wood placed horizontally with the upper edge inclining inwards, each bar overlapping the one beneath it, yet so as to leave an inch of clear space between them. The objects of this construction are to exclude rain, while interfering as little as possible with the free circulation of air, and to avoid any possible error arising from radiation. In order still further to guard against the latter source of error, the cage is surrounded by another of similar construction; they are nearly cubical in form with inclined close roofs, and open at the bottom. During the heat of the day they are defended from the direct rays of the sun by the observatory building, from the north wall of which the thermometers are eight feet distant.

The instruments are five in number; two, the ordinary dry and wet bulb thermometers, placed vertically, with their bulbs six inches apart, and the others, which are self-registering, placed horizontally. The highest temperature is shown by a Philips' maximum thermometer, in which a small column is separated from the body of mercury by a speck of air; on increase of temperature the column is forced forwards, but it does not recede when the temperature diminishes, thus forming an index of the highest temperature attained. The lowest temperature is observed by a Rutherford's spirit thermometer (with glass index) of the ordinary construction, and by a Casella's new mercurial minimum; the indications of the latter being remarkably consistent with those of the spirit thermometer.

Rain Gauge.—This instrument is placed on a level with the ground, about eighteen feet above the sea, and exposes a surface of 100 square inches for the collection of rain. The position selected for it, to ensure freedom from obstructions to the falling rain, is near the middle of an enclosure of an acre of land attached to the observatory, where it is 110 feet removed from the nearest obstacle, and 200 feet from the observatory.

Anemometer.—This is Robinson's arrangement, which consists of four hollow hemispherical cups attached to horizontal arms projecting at right angles to each other, from the top of an easily moveable vertical axis. The cups are so placed, that in revolving about the axis the convex side of each of them precedes the concave from whatever direction the wind is blowing, the velocity of rotation being nearly equal to one-third of the velocity of the wind. By the intervention of suitable toothed wheels, the axis (a portion of which forms an endless screw)

communicates its motion to a cylinder covered with paper, and a pencil is driven by clockwork from end to end of the cylinder in twenty-four hours; thus a curve is traced upon the paper by the combined motions of the pencil and cylinder, from which we can ascertain the space passed over by the wind from one moment of time to another. The hemispherical cups project two feet above the dome of the Observatory, which is fifty feet above the ground. As an indication of the delicacy of this instrument, it may be stated that it is the rarest possible occurrence to find the cups stationary even for a moment, happening perhaps not oftener than twice in a year; at which time *alone* the wind is too feeble to overcome the small amount of friction of the axis in its bearings.

Wind Vane.—The vane consists of a hollow parallelopepid without ends, fixed to the top of a vertical rod, which is capable of rotating freely about its axis, and to which is attached a divided circle with numbers, indicating the direction of wind. The vane is two and a-half feet above the dome.

EXPLANATION OF THE TABLES OF OBSERVATIONS.

With the aid of the following remarks, the headings of the different columns will be found sufficiently intelligible. The second and third columns contain respectively the mean barometric pressure, and mean temperature of the air, for each day, reduced by means of Mr. Glaisher's tables from the individual observations, and corrected for the errors of the instruments.

The tension of vapour is calculated from the numbers given in the second and third columns, and from the corrected mean readings of the wet bulb thermometer, by the following formula of Dr. Apjohn :—

$$f'' = f' - \frac{d}{87} \times \frac{h}{30}$$

for reading of wet bulb thermometer above 32°; and

$$f'' = f' - \frac{d}{96} \times \frac{h}{30}$$

for reading of wet bulb thermometer below 32°; f'' being the elasticity of vapour required; f' the elasticity corresponding to the temperature of the wet bulb thermometer; d the difference between the dry and wet bulb thermometers; and h the height of the barometer. The labour of calculation has been abridged by the use of a sliding rule, adapted to Apjohn's formula, invented by the late Mr. Welsh, by means of which the dew-point and relative humidity were also obtained.

By the dew-point is understood the lowest temperature at which the whole of the moisture contained in the air can remain in the state of vapour, any further cooling producing dew. If we represent by 1·00 the greatest quantity of moisture

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which can exist in the air in the condition of vapour at the temperature recorded in the second column, the number entered under "relative humidity" shows the proportion of vapour present on the day of observation. When fog prevails the air is saturated with moisture, and this number becomes 1·00. The tension of vapour is the quantity by which the elastic force of air (represented by the pressure of the barometer) *at the place of observation* would be diminished by extracting all the aqueous vapour from the air without altering its temperature.

In the eighth column the number 10 denotes that the sky is entirely clouded. The daily range of temperature (11th column) is the difference between the numbers in the two columns preceding.

It must be remarked that though the reduction of the observations of the barometer and dry and wet bulb thermometers, by means of Mr. Glaisher's tables, will generally lead to an approximate mean value for the day, and to a result very near the truth when several successive days are grouped together; yet, while it is the only method open to us, it is strictly applicable only to averages extending over a period of a month, as is implied by the headings of the tables of corrections, inasmuch as these are derived from *monthly groups* of observations for several successive years. On this account the corrected numbers will occasionally present an anomalous appearance, which in the case of temperature will be evident in the tables of observations, the calculated mean temperature exceeding the maximum, or falling below the minimum of the day, or the reduced mean temperature of the dew-point exceeding that of the air. On such days the variations of temperature do not possess the general character due to the season in which the observations are made. Nevertheless, as in the calculation of the monthly means, these days should have equal weight with others, it has not been thought desirable to omit the reduced daily means on these occasions.

Hourly movement of the wind.—These numbers are obtained from tabulations of the anemometer registers. The mean daily variation of the velocity of the wind (without regard to direction), is shown by the numbers in the last column for each month, from which it appears that the strength of the wind is greatest about noon, and least about midnight: and that between the hours 10 A.M. and 4 P.M., its velocity is decidedly above the mean, and below it between 11 P.M. and 7 A.M. The total movement for each day is given at the foot of the several columns.

As few observatories possess the means of supplying information on this subject derived from the records of an instrument of such delicacy and reliability, it is thought that these results are of sufficient interest to justify a more extended report of them than is given of the more ordinary meteorological elements.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Jan. 1	30·389	32·2	30·3	·93	·187	39·0	30·1	8·9	10, 10, 10	NE, NW, NW.	·000
„ 2	30·403	36·9	34·1	·90	·215	39·5	30·7	8·8	9, 8, 10	NE by N, NNE, NE by N.	·017
„ 3	30·020	35·8	35·5	·99	·226	41·0	32·6	8·4	10, 10, 0	SW, W by S, WSW.	·010
„ 4	29·868	37·5	30·0	·77	·185	40·8	33·3	7·5	1, 1, 1	NW by W, NW, W by N.	·018
„ 5	...	...	...	...	...	44·9	32·0	12·9	...	...	·006
„ 6	30·122	33·2	28·3	·84	·174	37·5	28·3	9·2	7, 4, 10	W, W by N, W.	·036
„ 7	29·064	40·2	37·6	·92	·243	43·7	30·2	13·5	4, 10, 10	SW, SW, SSW.	·000
„ 8	29·691	43·6	39·7	·87	·261	50·1	36·7	13·4	10, 10, 0	SSW, W by N, WSW.	·158
„ 9	29·701	49·3	45·3	·87	·318	52·6	36·0	16·6	10, 10, 10	SW by S, SW, SW.	·200
„ 10	29·786	47·7	43·5	·86	·298	51·7	43·3	8·4	2, 9, 2	SW by W, WSW, SW by S.	·037
„ 11	29·412	48·3	40·8	·77	·272	52·2	45·0	7·2	8, 10, 10	SW by W, SW, WSW.	·073
„ 12	...	...	...	...	...	47·4	36·2	11·2	...	...	·010
„ 13	29·736	38·5	36·5	·93	·234	43·7	32·3	11·4	11, 7, 10	—, W, —, SW.	·013
„ 14	29·628	40·0	37·7	·92	·244	42·3	33·8	8·5	10, 10, 8	—, ENE, NNE.	·130
„ 15	29·975	36·8	32·2	·85	·201	38·4	36·8	1·6	10, 10, 10	NNE, NE by N, NE.	·032
„ 16	30·074	32·2	28·0	·86	·173	36·6	30·8	5·8	6, 8, 0	SE by E, SE, SE.	·003
„ 17	30·059	27·7	26·2	·95	·162	29·8	24·2	5·6	10, 10, 2	SE, E by N, E.	·000
„ 18	30·080	27·4	...	...	...	30·8	21·5	9·3	7, 1, 1	ESE, SE by S, SE by S.	·000
„ 19	...	...	...	...	...	28·2	19·8	8·4	...	...	·000
„ 20	29·688	27·4	...	...	...	30·8	24·3	6·5	10, 9, 10	E by S, E, E.	·000
„ 21	29·536	30·6	29·1	·39	·180	32·2	26·3	5·9	10, 10, 10	ENE, E by S, ENE.	·000
„ 22	29·478	43·4	39·1	·86	·256	47·2	29·8	17·4	9, 1, 1	S by E, S by W, S.	·030
„ 23	29·565	39·5	37·0	·91	·238	49·0	35·7	13·3	9, 10, 10	SE by E, SE, SE by S.	·043
„ 24	29·469	48·2	40·8	·77	·272	49·9	38·6	11·3	8, 8, 2	SW by S, SW by S, SSW.	·072
„ 25	29·751	42·2	38·9	·89	·254	45·0	43·5	1·5	10, 10, 8	S, NW by N, NW by W.	·095
„ 26	...	...	...	...	...	...	27·6	...	...	...	·165
„ 27	30·174	40·9	34·4	·80	·217	45·1	...	...	7, 3, 3	SSE, SSE, SE by S.	
„ 28	29·819	43·1	39·3	·88	·258	39·0	35·6	3·4	10, —, 4	S, —, SSW.	·030
„ 29	29·726	49·7	45·3	·86	·318	52·9	40·0	12·9	10, 10, 10	SW by S, SW by S, SW.	·032
„ 30	29·682	46·8	43·6	·89	·299	54·3	47·9	6·4	9, 10, 10	SW by W, —, SW, —.	·082
„ 31	29·776	52·9	45·7	·78	·322	54·6	45·1	9·5	9, 10, 10	W by S, W, W by S.	·345
Monthly Means.	29·840	39·7	36·8	·87	·240	...	...	9·1	...	... ...	1·637

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.

JANUARY, 1862.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		8	8	3	11		9	2	17	15	17	13	17	9	4	6	4	9	10	10	6	21	15	10	14	16	5	2	10	13	16	24	10·8
A. M. 1		8	9	1	10		8	2	15	17	17	17	16	5	6	7	4	12	11	11	6	19	20	8	12	12	3	7	10	14	19	26	11·1
2		8	10	2	9		8	4	18	14	14	20	12	4	8	7	4	11	11	7	6	17	18	10	19	14	5	7	8	15	19	32	11·4
3		8	9	3	10		9	4	22	12	13	21	8	4	10	4	4	11	9	7	6	18	17	9	20	14	5	6	12	15	18	29	11·2
4		7	8	5	13		6	2	19	13	11	22	8	3	10	3	3	11	8	8	5	25	18	10	24	11	5	11	13	14	20	28	11·5
5		6	6	6	14	123	5	2	19	18	12	22	8	5	10	2	2	11	9	7	3	21	14	11	23	10	3	11	12	16	15	27	11·0
6		5	9	6	13		6	4	18	18	12	25	6	4	6	2	2	8	9	10	2	23	13	8	26	5	3	11	11	19	20	28	11·1
7		5	5	8	12		5	4	22	19	12	31	5	4	3	3	4	12	8	8	3	20	16	7	26	3	3	11	4	17	21	23	10·8
8		6	6	7	13		4	7	20	21	12	34	2	4	1	6	2	11	8	10	7	16	14	8	25	4	2	12	17	20	15	22	11·2
9		6	5	8	19		5	6	19	21	14	33	5	3	2	4	7	9	10	7	10	20	16	10	26	5	2	12	16	24	13	22	12·0
10		4	8	10	19	14	6	5	16	22	14	32	10	5	3	4	10	8	11	9	9	16	14	9	23	5	3	15	11	30	15	17	12·2
11		3	7	7	18	12	6	9	14	20	14	38	12	10	7	6	8	11	16	11	9	19	19	12	25	3	5	18	16	31	17	18	13·6
12		4	11	5	21	10	6	7	20	22	17	34	15	11	12	8	9	13	16	13	12	15	20	14	37	6	6	20	17	24	9	21	14·7
P. M. 1		3	10	4	12	10	7	8	17	21	15	35	15	9	13	5	8	11	16	9	13	9	18	17	34	11	15	21	17	25	8	20	14·1
2		1	10	5	11	9	3	6	15	22	12	31	16	7	10	7	8	12	13	6	12	7	18	19	31	14	12	19	15	20	7	22	12·9
3		3	8	6	11	6	3	6	14	22	14	34	13	6	10	7	3	9	10	4	15	9	15	21	30	11	8	15	20	15	4	22	12·1
4		2	8	5	8	5	1	9	11	21	11	39	14	4	9	8	2	6	9	6	16	10	10	20	27	10	6	12	19	19	2	22	11·3
5		2	7	5	7	8	3	8	7	19	13	31	12	2	7	6	4	7	8	7	16	6	8	23	30	6	6	10	18	14	1	22	10·4
6		3	6	8		6	2	8	8	18	11	28	11	5	8	7	4	4	9	6	18	9	15	19	34	6	7	8	18	17	2	21	10·9
7		4	5	7		8	4	8	4	20	11	26	15	6	11	12	4	4	7	8	17	6	8	21	29	5	5	11	16	20	3	25	11·0
8		2	4	6		5	3	7	9	17	9	28	14	7	8	6	3	5	8	8	20	5	9	19	29	5	10	14	14	16	7	17	10·5
9		1	3	8		8	3	8	6	16	10	28	16	5	9	4	8	7	8	4	25	6	11	15	24	5	6	11	15	16	15	21	10·7
10		6	3	5		9	3	7	10	17	8	29	14	8	8	6	12	10	9	5	22	9	9	16	22	6	3	11	15	17	18	22	11·3
11		12	1	10		9	2	14	10	20	6	18	13	6	9	6	10	10	10	7	18	10	9	11	13	4	3	13	13	14	18	17	10·5
12																																	
Total Daily Movement.		117	166	140	473		117	147	350	445	299	669	277	136	184	136	129	222	243	188	276	336	344	327	603	191	131	288	337	445	302	548	11·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Feb. 1	29·949	50·4	45·4	·84	·319	53·0	50·5	2·5	10, 10, 10	SW by W, W, W.	·000
„ 2	...	...	...	...	...	51·4	47·1	4·3	...	... ...	·000
„ 3	30·187	50·4	47·1	.89	·338	53·8	46·7	7·1	10, 10, 10	SSW, SW by W, SW by W.	·000
„ 4	30·210	51·3	48·2	·90	·351	54·4	47·2	7·2	10, 10, 10	W, SW by W, W by S.	·000
„ 5	30·030	48·7	43·9	·85	·303	53·3	45·3	8·0	8, 8, 5	WSW, WSW, WSW.	·000
„ 6	29·976	44·2	38·4	·82	·250	48·4	41·8	6·6	6, 8, 3	WNW, NE by N, N.	·000
„ 7	30·234	32·2	22·4	·70	·141	35·9	31·7	4·2	5, 1, 2	NE, WSW, NNE.	·000
„ 8	30·616	28·1	23·2	·84	·145	31·6	25·4	6·2	1, 6, 2	NE by N, ENE, NE.	·000
„ 9	...	...	...	...	...	37·3	24·0	13·3	...	... ...	·000
„ 10	30·467	36·0	27·4	·74	·169	40·8	32·0	8·8	7, 1, 0	N, NNW, NW by W.	·000
„ 11	30·226	36·5	34·5	·93	·218	41·7	25·7	16·0	10, 10, 10	SW by S, W, W by S.	·000
„ 12	30·037	41·0	37·9	·90	·245	44·4	31·7	12·7	10, 10, 10	NW by N, NNE, NNW.	·010
„ 13	30·090	35·7	32·3	·89	·201	38·0	35·3	2·7	10, 10, 10	NE by N, NE by N, —.	·008
„ 14	30·106	36·0	32·8	·89	·205	39·5	35·2	4·3	10, 10, 10	ENE, E by N, NE by E.	·000
„ 15	30·127	38·4	31·5	·78	·196	41·5	36·1	5·4	10, 10, 10	E by N, E, E.	·023
„ 16	...	...	...	...	...	41·9	33·0	8·9	...	... ...	·000
„ 17	29·442	39·8	40·0	1·00	·264	43·1	34·2	8·9	10, 10, 10	E by N, —, —.	·000
„ 18	29·379	48·7	44·3	·86	·307	53·4	38·8	14·6	9, 7, 9	SSE, S by W, S.	·147
„ 19	29·561	48·3	44·8	·89	·312	52·8	45·2	7·6	8, 10, 10	SE, S by E, SE by S.	·017
„ 20	29·619	50·3	43·3	·78	·296	54·5	47·1	7·4	8, 5, 1	SSW, SW, SW by S.	·109
„ 21	29·836	48·3	41·0	·77	·274	54·1	37·2	16·9	1, 2, 4	SSE, SE, SE.	·011
„ 22	29·764	48·3	43·9	·86	·303	52·5	43·1	9·4	8, 10, 10	E, ESE, SE.	·000
„ 23	...	...	...	...	...	50·7	45·2	5·5	...	... ...	·016
„ 24	30·090	37·5	33·9	·91	·213	40·4	39·6	0·8	10, 10, 10	E by N, E, E.	·000
„ 25	30·149	37·7	31·6	·81	·196	40·4	37·4	3·0	10, 10, 10	ESE, E, ENE.	·000
„ 26	30·349	33·0	28·3	·85	·174	35·4	34·0	1·4	10, 10, 10	NE, NE by E, ENE.	·000
„ 27	30·186	33·2	27·3	·80	·168	35·8	32·6	3·2	10, 10, 4	E, NE, NE.	·000
„ 28	30·018	35·2	27·9	·77	·172	39·3	32·9	6·4	9, 5, 10	ENE, ENE, NE by E.	·000
Monthly Means.	30·027	41·2	36·3	·84	·240	...	...	7·3	...	... ...	0·411

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—FEB. 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour.																													
12																													
A.M. 1	20	10	16	12	12	14	4	12	2	10	4		8	7	3	10	18	8	13	15	8	13	6	5	22	22	23	22	11·8
2	21	12	9	13	14	10	9	15	5	5	3		7	5	3	13	18	12	13	15	7	11	8	3	23	20	21	20	11·7
3	20	13	13	13	20	11	17	15	4	8	5		8	4	4	13	20	12	13	16	7	12	6	11	24	19	24	22	13·1
4	18	11	14	11	20	9	18	15	5	7	3		8	9	5	10	15	14	9	11	8	9	6	14	23	22	16	20	12·2
5	17	11	15	13	16	10	20	15	8	6	3		9	9	5	14	14	16	12	8	8	8	4	20	25	19	21	25	13·0
6	17	8	10	10	16	8	27	12	9	7	4		9	1	2	12	12	12	7	13	6	9	6	21	25	21	24	20	12·1
7	20	7	10	11	16	7	23	9	6	7	3		9	6	2	10	13	10	7	16	4	10	6	24	23	20	20	22	11·9
8	20	11	9	12	15	7	16	9	6	8	4		7	7	3	10	12	10	9	21	4	10	3	23	23	17	20	23	11·8
9	25	13	8	12	20	11	20	9	7	7	4		7	7	3	14	13	15	10	22	6	10	4	22	27	18	20	24	13·3
10	22	11	11	14	23	11	22	15	15	8	4		7	8	4	18	11	17	13	23	10	14	2	25	24	25	21	22	14·8
11	22	18	10	14	20	10		15	16	10		5	5	10	8	15	11	17	18	24	14	12	0	26	26	26	22	23	15·3
12	21	17	10	11	21	9		17	18	9		6	8	11	9	22	9	18	19	26	22	9	1	24	32	26	28	24	16·4
P.M. 1	26	20	15	11	18	11		15	17	13		9	5	10	12	21	9	16	18	32	22	6	3	27	32	25	30	23	17·2
2	24	16	12	13	20	10	125	12	17	13		8	4	8	10	21	4	22	19	28	22	4	2	25	30	25	27	22	16·1
3	20	14	13	14	15	10		11	15	10		9	5	7	9	23	3	20	16	28	22	10	3	28	34	25	29	26	16·1
4	22	15	7	12	13	10		9	15	9		8	5	4	11	29	1	19	15	27	25	10	6	30	30	20	31	24	15·7
5	18	12	7	13	15	6	13	7	14	8		10	2	5	10	25	3	12	15	23	23	11	2	32	30	23	29	24	14·5
6	12	12	4	12	10	4	6	7	11	8		8	2	9	7	20	1	14	14	17	17	6	3	26	28	20	28	24	12·2
7	13	13	9	12	12	6	5	5	9	4		5	1	5	10	16	3	16	16	18	16	3	2	31	32	20	26	24	12·3
8	14	16	11	11	12	14	4	5	11	6		2	2	1	8	15	3	14	17	18	17	5	3	32	28	20	23	23	12·4
9	9	17	4	10	12	10	6	5	10	5	123	7	1	2	9	15	3	10	19	13	12	3	2	27	24	20	22	27	11·3
10	10	16	8	10	11	10	7	4	10	3		7	1	7	9	19	1	14	19	9	11	4	3	30	22	22	17	26	11·5
11	12	19	12	12	12	8	12	4	10	4		10	1	10	9	19	2	15	20	10	14	6	3	34	20	20	21	25	12·7
12	8	13	12	11	10	4	10	2	10	3		4	7	5	8	16	4	10	15	10	10	4	4	23	17	21	18	22	10·4
Total Daily Movement.	431	325	249	287	373	220	364	244	250	178	258		128	157	163	400	203	343	346	443	315	199	88	563	624	516	561	557	13·1

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862.	Reduced to mean of day.					Temperature of Air			At 9·30 A.M., 2 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer corrected to Temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Mar. 1	29·251	35·5	26·5	·72	·164	41·5	33·6	7·9	10, 7, 6	NE by E, E, E by N.	·000
„ 2	...	...	...	...	...	34·4	31·7	2·7	...	...	·000
„ 3	29·260	31·3	25·3	·81	·157	37·2	23·5	13·7	10, 5, 1	SW, NW, NNW.	·000
„ 4	29·688	32·3	23·0	·72	·144	38·0	21·7	16·3	1, 3, 3	NW by N, NE, NW.	·000
„ 5	29·807	36·7	26·6	·70	·164	43·1	22·8	20·3	3, 8, 10	S, S, S.	·000
„ 6	29·522	49·5	47·3	·93	·340	54·4	36·1	18·3	10, 10, 10	SW by W, SSW, SSW.	·112
„ 7	29·427	50·9	46·4	·86	·330	56·0	47·9	8·1	10, 7, 3	SW, SW, SSW.	·098
„ 8	29·534	52·6	47·1	·83	·338	58·9	47·7	11·2	4, 9, 2	ENE, SE by E, SE by S.	·010
„ 9	...	...	...	...	...	50·3	44·7	5·6	...	...	·020
„ 10	29·946	47·5	42·8	·85	·291	53·4	41·4	12·0	10, 8, 6	W by S, W, SSW.	·151
„ 11	29·762	46·2	46·6	1·00	·332	51·5	41·7	9·8	10, 10, 10	SW by S, SW, SW by S.	·250
„ 12	29·690	47·8	40·3	·77	·267	53·2	44·8	8·4	10, 4, 3	SW by W, WSW, W.	·012
„ 13	29·981	46·2	44·7	·95	·311	52·4	41·7	10·7	10, 10, 10	NNE, NE, NE by N.	·050
„ 14	30·150	40·3	39·2	·96	·257	44.2	40·6	3·6	10, 10, 10	NE, NE, NE.	·031
„ 15	30·098	40·5	38·4	·93	·250	46·4	39·3	7·1	10, 9, 10	NE by N, NE, NE by E.	·008
„ 16	...	...	...	...	...	46·5	39·0	7·5	...	...	·000
„ 17	29·772	39·2	39·6	1·00	·260	46·5	40·4	6·1	10, 10, 10	SE, SSW, SW.	·400
„ 18	29·738	41·0	38·8	·93	·253	46·1	37·7	8·4	10, 9, 8	SW, NW by W, NW by W.	·220
„ 19	29·572	41·9	35·8	·81	·228	48·8	30·7	18·1	10, 4, 3	NE by N, NE by N, NE.	·005
„ 20	29·354	34·6	33·6	·97	·211	38·6	37·8	0·8	10, 10, 10	NNE, NE, NE,	·030
„ 21	29·521	33·1	31·1	·93	·193	38·0	32·8	5·2	10, 10, 10	NNE, N, N,	1·144
„ 22	30·003	36·6	27·6	·73	·170	41·1	34·1	7·0	10, 10, 9	N by E, —, ESE.	·032
„ 23	...	...	...	...	...	52·5	36·0	16·5	...	...	·175
„ 24	29·514	53·3	48·9	·86	·359	60·8	36·9	23·9	10, 9, 1	SW, —, SE.	·363
„ 25	29·448	51·9	51·4	.98	·391	59·0	45·0	14·0	10, 10, 10	SSW, E by S. E.	·008
„ 26	29·461	47·2	47·2	1·00	·339	53·2	44·3	8·9	10, 10, 10	E by N, E, E.	·063
„ 27	29·352	51·1	49·3	·94	·364	58·9	44·2	14·7	10, 8, 9	SE by E, NE by N, E.	·116
„ 28	29·186	44·5	43·6	·97	·299	49·5	45·4	4·1	10, 10, 10	NNW, NNW, N.	·093
„ 29	29·261	42·5	39·3	·89	·258	48·1	41·4	6·7	10, 10, 10	NNW, W, —.	·000
„ 30	...	...	...	...	...	52·3	42·0	10·3	...	...	·000
„ 31	29.586	48·6	45.0	·89	·314	56·2	44·3	11·9	10, 3, 8	W, WSW, SW.	1·081
Monthly Means.	29·638	43·2	39·4	·88	·269	...	...	10·3	...	... ...	4·472

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—March, 1862.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		26	8	4		6		21	17	19	12	6	5	3	22	12	13	7	9	2	17	22	13	17	11	1	5	7	7	7	1	3	10·4
1	A.M.	22	5	3		5		20	15	15	11	7	6	2	17	12	14	7	7	1	20	20	11	14	10	1	3	6	7	8	4	4	9·6
2	A.M.	20	4	3		4	286	20	19	13	8	7	7	2	15	14	13	8	7	1	19	20	12	16	15	2	5	4	8	7	7	3	9·8
3	A.M.	20	7	6		4		24	18	12	4	10	8	1	19	15	18	10	6	2	20	18	15	14	16	2	3	3	3	7	10	4	10·3
4	A.M.	22	8	5		4		19	8	15	5	11	6	2	16	16	16	7	7	2	21	17	11	15	15	3	2	1	6	6	6	6	9·6
5	A.M.	22	7	3		0·5		21	10	15	6	13	5	4	19	16	15	7	4	2	24	18	8	11	9	1	3	1	4	6	4	3	9·0
6	A.M.	18	8	5		4.5		24	8	18	6	17	5	4	20	18	15	6	4	1	22	20	7	12	8	2	6	1	3	6	6	4	9·6
7	A.M.	23	6	5		8		23	8	20	5	20	8	5	18	16	16	5	4	3	31	17	9	15	12	2	11	2	4	8	8	5	10·9
8	A.M.	20	3	7		11		29	9	22	7	21	10	10	17	19	16	5	5	9	26	20	11	15	8	3	10	3	6	5	6	5	11·7
9	A.M.	28	4	6		19		24	13	24	8	19	9	10	15	16	14	7	4	12	27	20	12	15	8	3	10	2	6	8	4	6	12·2
10	A.M.	21	6		9	23	26	30	14	34	8	18	11	9	18	18	15	9	5	15	27	16	11	18	9	4	10	1	5	8	3	11	13·7
11	A.M.	22	6		5	31	25	30	15	34	8	20	11	11	20	18	13	13	4	15	29	19	6	17	10	5	6	1	4	7	2	12	14·0
12		25	5		4	35	26	34	15	30	6	15	10	12	17	18	10	9	5	12	28	22	1	13	6	3	9	3	5	5	2	11	13·2
1	P.M.	25	5		4	36	30	31	17	30	4	14	3	10	16	17	10	16	7	16	31	21	2	15	4	3	10	4	6	5	4	10	13·5
2	P.M.	21	5		5	27	28	32	25	32	5	8	10	15	17	19	11	15	8	17	31	17	3	13	6	5	18	7	6	7	6	8	14·2
3	P.M.	25	5		6	28	27	33	19	39	2	14	11	16	17	18	10	13	7	19	27	13	6	10	9	8	18	8	7	4	6	9	14·5
4	P.M.	23	6		4	33	31	30	19	34	4	8	7	14	17	19	13	12	8	16	25	22	6	9	7	9	14	9	9	5	8	9	14·3
5	P.M.	21	4		1	28	32	30	17	26	4	7	5	15	16	21	8	10	5	14	26	18	6	8	7	6	16	8	7	3	7	8	12·8
6	P.M.	24	5		2	33	35	26	19	29	5	8	5	17	17	20	12	11	2	12	25	18	5	18	5	9	15	11	5	2	4	12	13·7
7	P.M.	22	5		4	30	27	24	20	27	8	7	3	21	18	17	11	11	1	15	28	19	9	17	4	5	14	12	7	5	4	9	13·5
8	P.M.	10	2		3	33	25	22	23	23	4	8	4	21	18	13	10	13	1	19	27	17	8	19	4	4	13	14	10	3	4	9	12·8
9	P.M.	7	3	200	5	36	23	22	26	21	5	9	3	17	18	13	13	11	1	17	25	16	9	15	1	2	10	17	10	3	2	9	12·3
10	P.M.	7	5		6		27	24	30	16	7	7	3	19	14	14	12	10	1	16	18	14	10	15	2	3	12	13	9	4	6	10	11·5
11	P.M.	9	4		5		23	17	21	8	5	6	1	17	14	13	8	7	1	15	22	14	13	14	1	8	7	8	6	2	6	10	9·8
12																																	
Total Daily Movement.		483	126	310		1110		610	405	556	147	280	156	257	415	392	306	229	113	253	596	438	204	345	187	94	230	146	150	131	120	180	12·1

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*March* 19.

THE LAST ELEVATION OF THE CENTRAL VALLEY OF SCOTLAND, BY ARCHIBALD GEIKIE.—After alluding to the position and nature of the raised beach which, at the height of from twenty to thirty feet above the present high-water mark, fringes the coast-line of Scotland, the author proceeded to describe the works of art which had been found in it. From their occurrence in beds of elevated silt and sand, containing layers of marine shells, it was evident that the change of level had been effected since the commencement of the human period. The character of the remains likewise proved that the elevation could not be assigned to so ancient a time as the Stone Period of the archæologist. The canoes which had from time to time been exhumed from the upraised deposits of the Clyde at Glasgow clearly showed that at the time when at least the more finished of them were in use, the natives of this part of Scotland were acquainted with the use of bronze, if not of iron. The remains found in the corresponding beds of the Forth estuary likewise indicated that there had been an upheaval long after the earlier races had settled in the country, and that the movement was subsequent to the employment of iron. From the Firth of Tay similar evidence was adduced to indicate an upheaval possibly as recent as the time of the Roman occupation. The author then cited several antiquaries who from a consideration of the present position of the Roman remains in Scotland had inferred a considerable change in the aspect of the coast-line since the earlier centuries of the Christian era. He pointed out also several circumstances in relation to these Roman relics, which tended to show a change of level, and he referred to the discovery of Roman pottery in a point of the raised beach at Leith. The conclusion to which the evidence led him was that since the first century of our era the central parts of Scotland, from the Clyde to the Forth and the Tay, had risen to a height of from twenty to twenty-five feet above their present level.

ROYAL SOCIETY.—*March* 20.

EXHIBITION OF M. PLATEAU'S FILMS.—Dr. Frankland exhibited before the society a series of very beautiful experiments with the solutions and apparatus of M. Plateau, designed to show the optical and mechanical properties of thin films. The films are obtained by means of a solution of one part of pure oleate of soda in fifty of water; three parts of this solution are then mixed with two parts of glycerine. The liquid thus obtained is capable of being blown, by means of a common tobacco-pipe, into bubbles of very large size

and great permanency. Dr. Frankland stated that he had succeeded, by means of a blowpipe bellows, in obtaining a bubble nearly nineteen inches in diameter. When inflated with air these bubbles often last more than twenty-four hours; but, when the breath is employed, the oleate of soda is slowly acted on by the carbonic acid expired, and their duration is limited to three or four hours.

A series of these bubbles, about six inches in diameter, were placed on a number of glass rings situated in a line, and on a ray of light from the electric lamp being transmitted through the series, their beautiful iridescent colours were developed in the most magnificent manner.

Other bubbles were inflated with a mixture of eight parts of air and one part of coal gas, which, by overcoming the specific gravity of the film, enabled the bubbles to float in the atmosphere so as to be wafted by the slightest current. The tenacity of the film was shown by allowing drops of water to fall through the bubbles which could be accomplished without breaking them.

By dipping small wire cages forming the outlines of geometrical solids, into the mixture of oleate of soda and glycerine, plane films were produced intersecting each other in various directions in the interior of the wire frames. Many of these offered very remarkable geometrical combinations; the wire outline of a tetrahedron, for example, on being withdrawn from the solution, was shown to contain six triangular films, all meeting at the centre of the figure.

The films, formed in the cages which represented the outlines of short rectangular prisms, were in several cases bounded by curved lines, the mathematical properties of which have been closely investigated by M. Plateau.

SOCIETY OF ARTS.—*April* 2.

Oxidized Oil as Substitute for the Elastic Gums.—Mr. F. Walton described the manufacture of a new substitute for gutta percha and India-rubber, consisting of oil oxidized by exposure to the air in thin films, and subsequently either dissolved in a volatile solvent, or worked up in a solid form. By these means an elastic solid is obtained, possessing in a great degree the properties of rubber in its various conditions, and applicable to similar purposes.

LINNEAN SOCIETY.—*April* 3.

On the Fertilization of Certain Orchids.—Mr. C. Darwin described some remarkable peculiarities existing in certain orchids, specimens of which were in the possession of the Linnean Society. In the plants belonging to the genus *Catasetum*, it not unfrequently happens that two, and sometimes three, supposed distinct genera exist on the same spike. Thus the *Catasetum tridentatum* is intermixed with the flowers of the *Monocanthus viridis* and those of the *Myanthus barbatus*.

Mr. Darwin has ascertained that the *Catasetum tridentatum* is the male form, the flowers bearing pollen masses only; that in the so-called *Monocanthus* the pollen masses are rudimentary, the inferior ovary being well-developed and twisted, as is usual in orchidaceous plants, and, further, that the so-styled *Myanthus barbatus*, which is borne on the same plant, is merely the hermaphrodite form.

Mr. Darwin remarked on the very extraordinary mechanism which was necessary to ensure the fertilization of the orchids of the unisexual flowers of the genus *Catasetum*. The pollen masses are attached to elastic fibres, held down by a membrane, and each is furnished with an adhesive disk. The flowers are furnished with antennæ; when these are touched by any object, as an insect, the elastic fibres project out the pollen mass with such force that its adhesive surface adheres to the insect, which, in its search for honey, conveys it to the stigmatic surface of the pistil bearing flower.

Mr. Darwin stated that the position of the excitable surface of the flower varied in the different species, but that the projection of the pollen mass was, in all cases, in such a direction as to cause its attachment to the insect passing over the irritable surface.

Total Amount of Australian Gold introduced into England.—Professor Tennant exhibited some rich specimens of auriferous quartz from Nova Scotia, and also the first specimen of Australian gold that was brought to England. This nugget was exhibited at the Great Exhibition of 1851. Since that time 1000 tons of gold have been imported into this country from Australia, the value of which cannot be estimated as less than about £143,000,000.

ENTOMOLOGICAL SOCIETY.—*April* 7.

Silk-producing Moths of Asia.—Mr. F. Moore exhibited a magnificent collection of the various silk-producing moths of India, with specimens of their cocoons and samples of the silks in their raw and manufactured states. The best silk is yielded by the common silkworm, the *Bombyx mori*, which is now so generally cultivated; it is an annual, and feeds on the mulberry. Many other species of *Bombyx* are also known and cultivated, some yielding several crops of silk every year. Specimens of eleven distinct species are contained in Mr. Moore's collection.

The genus *Attacus* contains several species of silk-yielding moths. The Tusseh cloth of China is said to be produced by the *A. atlas*. And the *A. Cynthia*, which is known as the *Eria*, or the *Ailanthus* silkworm, from feeding on the leaves of that plant, exceeds six inches in length in China, where it has been cultivated for centuries, and clothes large masses of the people.

The *Eria* has been introduced into the south of Europe, and has been successfully cultivated in many parts of France, as has also a hybrid between it and the Bengal Eria, *Attacus ricini*, this latter also feeds freely on the leaves of the castor-oil plant, *Ricinus communis*.

The *Actias selene* is domesticated at Mussooree, where it yields

four crops of silk annually. The Moonga, *Antheræe assama*, is extensively cultivated in the open air in Assam; the silk forms one of its principal exports. There are generally five broods during the year.

The *Antheræa paphia*, or Tussur, or Tusseh silkworm of the Bengalese, is very widely distributed throughout India; its silk is a most abundant product; it is the most common in use of all the wild silkworms, millions of cocoons are annually collected in the jungles, and brought to the silk factories near Calcutta. Other species of *Antheræa*, as the *A. Roylei*, feeding on different species of oak, have also been cultivated.

In addition to the moths above enumerated, the collection of Mr. Moore exhibited several others belonging to the genera *Cricula*, *Salassa*, *Saturnia*, etc., etc., many of which, it is evident, may be made largely available for the production of different silks, having various qualities likely to render them useful to man. This unique collection will be shown in the Indian department at the International Exhibition.

ZOOLOGICAL SOCIETY.—*April* 8.

The Lepidosiren.—Dr. T. Spencer Cobbold, F.L.S., gave a minute description of the bones of the skull of *Lepidosiren annectans*, which animal differs so materially from that of the American species (*Lepidosiren paradoxa*) that some have taken it for a distinct genus, under the title of *Protopteris*. The New World species, discovered by Natteur, has been carefully anatomized by Bischoff and Hyrtle, whilst the one under consideration has been dissected and described by Owen, Melville, M'Donnell, and others. The osteology of *Lepidosiren annectans*, however, is still incompletely understood. Dr. Cobbold observed that three, or at most four, bones only were concerned in the formation of the cranium proper, whilst four others formed the face, two of them belonging to the jaws. He stated that there were no true superior maxillary bones, the upper massive jaw being in reality made up of the enormously developed palatine bones. The most remarkable cranial elements are the pair of horn-like bones which stretch backwards to form the vault of the skull. Bischoff says they are altered molar bones, but Dr. Cobbold considers them to be the frontals, and he observed that "their presence more than any other of the osseous elements imparts to the skull its unique character." There are many striking differences in the skeletal element of *Protopteris annectans* as compared with *Lepidosiren paradoxa*.

NOTES AND MEMORANDA.

STAR FINDER.—Messrs. Horne and Thornthwaite have supplied a want widely felt by the possessors of telescopes, in producing, a small, portable, and elegant instrument, by which celestial objects may be easily found from the data given in the *Nautical Almanack*, or any similar authority. It is, in fact, a miniature equatorial of accurate workmanship and very moderate price. We regret that the demands upon our space oblige us to postpone any detailed description, but it is due to our astronomical readers to give them the earliest intimation of a new and important aid to their favourite pursuit.

TARANAKI STEEL.—We have received from Messrs. Moseley a specimen of that very curious and interesting mineral, the iron-sand from New Zealand, which appears to realize all the expectations which were formed of its value in metallurgy. The chemical composition of this ore, for such it must be called, is eminently favourable for the production of the finer kinds of steel, as it not only contains no element of a deteriorating quality, but has the great advantage of possessing a considerable quantity of titanium. In appearance the Taranaki sand resembles bright grains of gunpowder, and is readily attracted by the magnet. Professor Herapath says it contains 16 per cent. of titanium, 6 of silica, and a trace of manganese. The deposit extends for miles on the beach, at the foot of the volcanic mountain Egmont, and when smelted yields 60 per cent. of iron of the first quality. Under the microscope it presents a beautiful appearance, the grains exhibiting very irregular but polished surfaces, with a lustre between that of steel and silver. Here and there a grain will be observed, composed chiefly of silica, dotted with minute portions of the ore, but it is singularly free from impurities. The steel made from it is highly praised, and when we remember the extraordinary affinity of titanium for nitrogen at high temperatures, we call to mind the recent assertion of a French chemist on the action of the last-named element in changing iron into steel.

LINKS BETWEEN FEATHERS AND SCALES.—Mr. Latham exhibited to the same Society scales from the wing of the Catarrhactes papua, a penguin from the Falkland Isles. They appear intermediate between feathers and scales. This fact should be considered in connection with the discovery of the feathered reptile in the Solenhofen slate.

THE MASS OF JUPITER.—M. Schubert expects to be able to calculate the exact mass of Jupiter from the disturbances he produces on the asteroid Leucothea.

ASTRONOMICAL PHOTOGRAPHS.—The beautiful photographs of M. Warren de la Rue are a most valuable contribution to astronomical science. By means of his labours we are obtaining a continuous history of the changes in the spots and faculæ on the face of the sun, more accurate and more instructive than could be preserved by any verbal description or ordinary drawing. By this means questions relating to the periodicity of these changes and their connection with terrestrial magnetism will be solved, and likewise those concerning the movements of the supposed ring of asteroids in the region of Mercury. Among the most remarkable of Mr. de la Rue's works are stereoscopic views of the larger planets. As it would be impossible to stereoscope objects so remote by the usual methods of operation, he has obtained the requisite change in the aspect of the two views by photographing the planetary disks in two positions at two different periods of observation.

THE SODIUM SPECTRUM.—Mr. Fizeau called the attention of the French Academy, on the 3rd March, to the character of the light obtained by burning the metal sodium in common air, when examined with the spectroscope. He observed, "the results differed entirely from those obtained with other flames in which the presence of sodium is revealed in a very constant manner by a yellow light, which, when observed in the spectrum, presents the double ray D detached from the background, and very luminous. The effects produced with the burning sodium do not coincide with the expectation of a great development of the ray D, and we find with surprise that the spectrum it produces is continued after the red as far as the violet, with the exception of the double ray D, which detaches itself in shaded black (noir foncé), and like velvet on the brilliant ground of the spectrum. This appearance is the converse of that which is given by other flames containing sodium. With them, in fact, all the rays of the spectrum are wanting, with the exception of that which forms the ray D. With burning sodium all the rays are very brilliant except those of the ray D, which appear entirely absent.

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This phenomenon only occurs when the combustion is vivid. When the metal begins to burn, the ray D shines on the black ground; as the combustion becomes more active it developes in one part and another of the ray D, which it enfeebles, intense rays, which at first do not pass beyond its immediate vicinity, but which rapidly invade the whole expanse of the spectrum with ordinary tints as the sodium becomes completely on fire; and at last there is observed only the rays of the double ray D which detaches itself in intense black—that is to say, with the same appearance as in the spectrum formed with the light which emanates from the sun."

Trepidation of the Soil at Nice.—From a letter by M. Prost to M. Elie de Beaumont, published in *Comptes Rendus*, we learn that, during the late eruption of Vesuvius, tremblings of the ground occurred at Nice, varying suddenly in force and direction.

The Companion of Sirius.—Mr. Clark, of Cambridge, U.S., has discovered, and Mr. Bond has verified, the existence of a companion of Sirius, distant 10″. It had been suspected by Bessel and Peters, on account of certain periodical perturbations in the right ascensions of the great star, and was conjectured to be a dark body, as it could not be found before Mr. Clark's fortunate observation with an 18-inch instrument. The companion of Sirius has been seen at Paris (since its discovery in America) with M. Foucault's large telescope, with a silvered mirror, 80 centimetres. It is visible only when atmospheric conditions diminish the radiation from the great star. Mr. Peters has written to *Cosmos*, stating that it cannot be identified with the body whose existence he suspects. The exact distance of the little star is 10″·5, angle of position 85°.

Carbon and Hydrogen.—M. Berthelot, who has been long engaged in forming hydro-carbons by a synthetical process, has recently made a remarkable experiment by passing a current of hydrogen between the charcoal points of a Bunsen's battery of 60 elements. At this extreme temperature the hydrogen combined with the carbon producing a cetyline. The facts were communicated to the French Academy by M. Balard on the 17th March.

Vocal Fishes.—Dr. Dufossé communicates to the French Academy further researches into the vocal powers of certain fish, most of his observations being made upon species of *Trigla* and *Zeus* (gurnards and dories). He states the sounds to be produced by the vibration of the muscles belonging to the air-bladder, and that large gurnards may be heard at a distance of six or seven yards. Out of five or six hundred individuals of the species mentioned, their voices were comprised between si_2 and re_5 inclusive. The sounds were instantaneous, or prolonged for several minutes, sometimes as long as seven or eight minutes. The pitch often varies during a single "sonorous emission." The finest vocal performers appear to belong to the species *Morrude*, who surpass all their congeners in producing a great number of completely distinct sounds. "They sustain the simple sounds better, and modulate better the compound sounds; they render more distinctly long successions of sounds different in tone and pitch; in fine, there is less dissonance in the sonorous vibrations they produce. Other species, however, beat them in intensity."

Microscopic Writing.—The President of the Microscopic Society of London stated in his annual address that the beautiful machine presented by Mr. Peters has enabled the Lord's Prayer to be written in the 356,000th of a square inch—a space like a minute dot. The English Bible contains 3,566,480 letters. The Lord's Prayer, ending with "Deliver us from evil," 223 letters; so that the Bible is 15,992 times longer than the prayer, and if we employ round numbers, we may say it could be written in 16,000 times the space occupied by the prayer, or in less than the twenty-second part of a square inch. In other words, the whole Bible might be written twenty-two times in one square inch. This wonderfully minute writing is clearly legible when placed under a good microscope. In using the machine, the operator writes with a pencil attached to one end of a long lever; whatever marks he makes on a piece of paper are infinitesimally reduced in corresponding motions, by which a glass plate is moved over a minute diamond point. By means of Ibbetson's geometric chuck, beautiful geometric designs may be engraved on a similar scale of minuteness.

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